Railway Age Gazette
MECHANICAL EDITION
INCLUDING THE
AMERICAN ENGINEER

PUBLISHED ON THE FIRST THURSDAY OF EVERY MONTH BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY,
WOOLWORTH BUILDING, NEW YORK, N. Y.

CHICAGO: Transportation Bldg. CLEVELAND: Citizen's Bldg.
LONDON: Queen Anne's Chambers, Westminster.

EDWARD A. SIMMONS, *President* L. B. SHERMAN, *Vice-President*
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Subscriptions, including the eight daily editions of the *Railway Age Gazette* published in June in connection with the annual conventions of the Master Car Builders' and American Railway Master Mechanics' Associations, payable in advance and postage free:

United States, Canada and Mexico	$2.00 a year
Foreign Countries (excepting daily editions)	3.00 a year
Single Copy	20 cents

Entered at the Post Office at New York, N. Y., as mail matter of the second class.

WE GUARANTEE, that of this issue 4,400 copies were printed; that of those 4,400 copies, 3,640 were mailed to regular paid subscribers and 150 were provided for counter and news companies' sales; that the total copies printed this year to date were 13,050—an average of 4,350 copies a month.

VOLUME 88 MARCH, 1914 NUMBER 3

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Car Department Competition

The article on steel freight car repair shops prepared by E. T. Spidy, general shop foreman, Canadian Pacific, Winnipeg, Man., has been judged the winner of the car department competition which closed on February 1, 1914. Mr. Spidy's article is published in this issue and he has been awarded the prize of $50. Several of the other articles submitted in the competition were of extremely high merit and have been accepted for publication. They will appear in later numbers.

Strength of Locomotive Boilers

Boiler form No. 4 for the Interstate Commerce Commission requires something more than the mere filling out of existing records, as many of our readers realize. Careful calculations must be made and, when conscientiously done, result in a large amount of computation and search for suitable formulas. William N. Allman has had considerable experience in connection with filling out this form and has evolved a number of formulas to simplify the work which he explains in an article in this issue. While there may be some who will criticize his reasoning and object to his conclusions, still the fact remains that, for the first time, this whole matter has been put in such form as to be readily available for use in this connection. The tables he gives relating to the shearing value of rivets and the safe load on staybolts will, no doubt, be particularly appreciated.

Making Reports for the Government

A mechanical engineer of one of the large western roads recently stated to a caller, "I am not really mechanical engineer of this road any longer. While I still carry the title, almost all of my time is now devoted to making reports required by the government, our own legal department or some smoke commission, when I am not attending hearings and committee meetings on the same subjects." Another motive power official of an eastern line recently remarked, "The matter that we were considering a month ago is still untouched as my entire time since that date has been devoted to answering a few of the questions requested by the Interstate Commerce Commission in connection with the rate hearing. The pile of papers you see there (a foot high) is part of the data I have been collecting." These are by no means exceptional instances, and on some roads the governmental activity in connection with railroads requires so much of the time of motive power officers that a special consulting engineer has been employed to devote his whole time to these matters. If the work of the department is to progress satisfactorily, the other roads will have to do the same thing and may eventually even have to organize a corps of men for this work.

$100 for Data as to Best Type of Draft Gear

One who has given the subject of draft gear for freight cars much thought and study is responsible for the statement that the use of inferior draft gears is costing the railways of this country 250 million dollars a year; this on the basis of the damage to equipment, the loss and damage to freight, delays to traffic due to defective equipment caused by inferior draft gears, and congestion at terminals due to bad order cars, etc. Is he right? Has he underestimated or overestimated the amount involved? There are less than two and a half million freight cars in this country.

For many years improved draft gears and friction draft gears have been in the course of development. It would seem from the great amount of attention which railroad men have given to the draft gear problem that there is little question but what the older types of gears are inadequate. Many thousands of freight cars are now equipped with the improved gears. The Master Car Builders' Association has tested the various types of gears under the drop testing ma-

chine and also by static tests in the laboratory. These results have been published broadcast, but the practical railway man has hesitated to place too much reliance upon them because the conditions under which the load was applied were so different from those encountered in actual practice. In a few cases railroads have made road tests, and these have contributed certain facts to our knowledge of the gears; but here, too, it is difficult to duplicate conditions in order to make comparative tests. Then, too, in all these tests the question enters as to whether the gears, tested when they were new, or practically so, would give equally as good results after they had been in service for a year or several years. Certain tests have been made by one or two of the railways and manufacturing concerns with special testing machines which are claimed to very nearly approximate service conditions in applying and releasing the load; the results of these tests, however, are not widely known and have never been available for publication.

After all, the results which are really worth while are those which are obtained in service. Here again, however, a serious difficulty is met with. Freight cars are so generally interchanged and spend so much time on foreign lines that it is hardly possible to keep an accurate check on them individually, as is the case with passenger cars and locomotives which seldom, if ever, leave the road or system. J. C. Fritts, master car builder of the Delaware, Lackawanna & Western, showed, however, in a paper on "Freight Car Troubles," which he read before the September meeting of the Central Railway Club, and which was published in the Railway Age Gazette, Mechanical Edition, for September, 1913, that it was possible to secure fairly accurate information as to the comparative service of different types of draft gears.

Many railroads have placed special draft gears on their equipment in fairly large quantities, and in a number of cases a large order of cars of the same design has been divided into several parts, each using a different type of draft gear. Surely, even if it is not possible on all roads to follow it up to the extent that Mr. Fritts did on the Lackawanna, the differences between the different types of gears, if they are as great as we have been led to believe, would be apparent by the difference in the repairs which are required by the different cars and in the physical condition of the cars after extended service. It would seem that the time has come when some of this data, of a fairly accurate and convincing nature, should be available. If there is so great a difference between the newer and older types of draft gear the fact should be given the widest publicity in order that the railways may protect themselves against the ever increasing expense to which they are subjected. So great is the importance of this subject that we propose to offer a prize of $100 for the best article received in this office on or before May 15, 1914, on the draft gear problem. The subject may be discussed from any viewpoint, depending upon the experience and observations of the author; *but* the judges will base their decision on facts and evidence to show what types of draft gears are giving the best results. Articles not awarded the prize but accepted for publication will be paid for at our regular space rates.

Lehigh Valley Locomotive

It is seldom that an anthracite burning locomotive presents as pleasing an appearance as the Pacific type engines recently designed and built by the Lehigh Valley, which are illustrated and described in this issue. As will be seen by reference to the speed chart, these engines are capable of a rather remarkable performance and are now daily doing the work which formerly required two locomotives that, together, had a tractive effort fully 50 per cent greater than the new design. In keeping with the latest practice in respect to superheater locomotives, the factor of adhesion has been made rather low; in other words, the locomotives would appear to be over cylindered if judged by previous standards. When, however, it is remembered that a superheater locomotive should work at a cut-off in the neighborhood of 30 per cent for the most efficient steam consumption at high speeds, the explanation of the ratio is clear. The designer of these locomotives has striven for a valve design and setting which will give an even turning movement at the crank pin and thus an even drawbar pull. How well he has accomplished this result is shown by one of the curves in the article which indicates that the turning movement varies but slightly for a full stroke, the power of both cylinders being considered. Similar curves from some other locomotives of the same size which have not been given the same study, show a surprising variation.

Electrification of Mountain Grades

An article by Joseph T. Ripley in the February 13 issue of the Railway Age Gazette gives a brief summary of a study made to determine the advantages, if any, of electrifying the 23-mile section of the Santa Fe between Trinidad, Col., and Raton, N. M. The Raton Mountain is about seven miles from Raton and 16 miles from Trinidad. The grades on this section are 3½ per cent opposed to westbound traffic from Trinidad to the summit and 3.32 per cent opposed to eastbound traffic. The maximum curvature is 10 deg. and it is estimated that about 50 per cent of the line is on curves. Of all the lines owned by the Santa Fe, this section seems to be the most susceptible to electrification with resultant economy and hence it was selected for this study. A careful analysis was made of the tonnage handled over the mountain, both daily, monthly and yearly. The average number of freight trains per day was assumed to be twelve, six in each direction, and there were eight passenger trains, four in each direction. The yearly tonnage was found to be 2,720,000 tons westbound and 1,915,000 tons eastbound.

In preparing the estimates, four sources of power supply were considered and four different electrical systems were studied and cost estimates were prepared for each with each of the different sources of power. These electrical systems consisted of direct current at 1,200 volts, direct current at 2,400 volts, single phase current at 11,000 volts and three phase current at 6,600 volts. In deciding the requisite power station capacity for each, the assumption was made that, at the time of congestion, it might be necessary to move simultaneously up grade at speeds of 12 and 15 miles an hour, respectively, two freight trains of 1,639 tons each and two passenger trains of 600 tons each. This led to the conclusion that in each of the four electrical systems a station containing four 3,000 k.w. units would be of ample capacity.

In arriving at the most economical size of electric locomotives to be used, time space diagrams were plotted for each of seven rated locomotive tonnage capacities, ranging from 300 to 600 tons conclusively, these diagrams being made on the basis of the average train tonnage during the month of May, 1912. It was finally concluded that thirteen 115 ton electric locomotives would handle the traffic to the best advantage with the minimum outlay of capital. Careful estimates, based on statistics available, were made of the expense for enginemen's wages and the cost of electric locomotive maintenance and repairs. In the latter case 4.06 cents, 4.85 cents and 5 cents per locomotive mile were assumed for a direct current, single phase and three phase system, respectively. Proper depreciation charges were also carefully fixed and other items of expense were conservatively estimated in accordance with available records of electrified trunk lines. It was finally ascertained that the use of a single phase system obtaining power from a plant constructed and operated by the railway and using coke oven gas as fuel, gave the highest return on the necessary capital invested. With this combination it was found that it would require nearly $2,000,000 increase in capital charge after the cost of the steam locomotives, that would be replaced, had been subtracted.

The total annual operating expenses of the electric locomotives were found to be $124,445 against $244,398 for steam. The fixed charges, exclusive of interest, for the electric service were $127,373 and for the steam service $20,370. This gave a total of operating expenses and fixed charges, exclusive of interest, for the electric, $251,818, and for the steam, $264,768, a difference in favor of the electric of $12,950. Since the plant was figured on the basis of the sale of electric power to a nearby manufacturing plant, which would bring in an income of $50,000 a year, this gave the total difference in favor of the electric service of $62,950 a year or 3.18 per cent return on the increased capital charge.

The study as a whole indicated that it would show a profit of any kind only in connection with a power plant constructed and operated by the railroad company. For the type of plant assumed above, using coke oven gas as fuel, it was found that the direct current at 1,200 volts would give a return of 1½ per cent annually on the capital, direct current at 2,400 volts would return 2.35 per cent, single phase 3.18 per cent and three phase 1.44 per cent. If coal was used as fuel for the same power plant, direct current at 1,200 volts would return .32 per cent, at 2,400 volts, .99 per cent, single phase would return 1.63 per cent, while the three phase would show a deficit of over $2,000 a year. If power was purchased from outside sources deficits ranging from nearly $4,000 to over $62,000 a year were shown. In this connection it should be understood that the power plant would be located in a region where coal is cheap. The opportunity for using water power was considered, but did not prove feasible.

Pennsylvania Brake Tests

It is probable that Mr. Vaughan expressed the sentiments of every one who has had an opportunity of carefully reading the report of the tests of brake performance on passenger trains made by the Pennsylvania Railroad in 1913, when in discussing Mr. Dudley's paper before the recent meeting of the American Society of Mechanical Engineers, he said, "I feel that the United States ought to be proud of having a railroad company in its domain with energy enough and interest enough in the subject of brakes to devote time and money to such an extent as was necessary to carry out a series of tests of this kind, and also proud of the fact that any railroad company is equipped with a sufficient corps of trained men to take the observations required in the investigation reported in this paper. I think it is a magnificent testimonial to the scientific side of the operation of American railways and a credit to the whole country that the presentation of a paper like this should be at all possible." This, of course, is not the first time that the railroads of the country have been indebted to the Pennsylvania for thorough investigations of this kind. As has been stated in these columns before, the broad minded policy of the management in respect to the activity of the motive power department and the facilities possessed for making complete engineering investigations, places the Pennsylvania in an enviable position among the railroads of this country. It is probable that, unless the government organizes a bureau of railroads, similar to that it now has for mines, we will have to continue to look to the Pennsylvania for accurate engineering information on the operation of the latest important developments of broad scope on both locomotives and cars.

In fairness to those of our readers who may not be particularly interested in this subject, it has seemed advisable to devote only sufficient space in this issue to give a general outline of the character of the tests, the equipment used and the results obtained. Those who are interested in the details of the test can obtain copies of Mr. Dudley's paper or of the complete report from the Westinghouse Air Brake Company.

In the discussion of the paper T. J. Kelley, consulting air brake engineer of the New York Central Lines, pointed out that the percentage of braking power, if employed within reasonable limits, is not necessarily in itself the cause of wheel sliding, especially with the ordinary design of truck and brake rigging. It is frequently due to the uneven distribution of the forces over the different wheels of the truck, and particularly of the different cars of the train. He points out that while the clasp brake gear will not dispense with the shock it will go a long way toward keeping the wheels in the truck about in their normal position with relation to other parts so that whatever spring action is available will tend to keep the wheel where it belongs and the rail adhesion uniform. Furthermore, he believes that the clasp brake will go a long way toward giving freedom from hot boxes because, with the modern percentage of braking power, with all the pressure on one side of the wheel, it brings a considerable thrust on the journal, which is often productive of heated bearings.

Mr. Vaughan in his discussion commented on the marvelous ingenuity of the whole apparatus in connection with the U. C. equipment, but suggested that it might be possible to design an electro-pneumatic brake which would be much simpler, provided it was not required that it should be interchangeable with the present equipment. He believed that it would not be a serious matter to carry two sets of brakes on the trains during the transition period, and pointed out the fact that in Europe cars which carry four sets of brakes are frequent. He asked where the railroads would be able to get men at 25 cents an hour who would be able to tell what was wrong with such a complicated equipment as that shown in the paper. He was frank in saying that, as a railroad man, he was afraid of this new equipment. While it is a beautiful piece of apparatus, if we could get a simple electric control (and it does not seem that the difficulties are insurmountable) and thus obtain a simple, cheap brake that the repair men can understand, on which they can locate the trouble and know what they are doing, it would be very much better than the equipment shown. Mr. Turner, chief engineer of the Westinghouse Air Brake Company, agreed with Mr. Vaughan in regard to having as simple an apparatus as possible, but stated that if it is desired to do the things which are necessary to control the trains today, particularly during the transition period, it is essential to have substantially the apparatus shown. He believes that the two or three brake equipments which would have to be carried according to Mr. Vaughan's idea, would be as complex as the U. C. equipment.

Some tests recently made on the New York, Westchester & Boston to determine the efficiency of the clasp brake rigging were quoted by R. R. Potter of that road. The electrically operated cars of this line weigh about 120,000 lb., and in making the tests motor trucks having clasp brakes were put under both ends of the car. From 35 miles an hour the deceleration in an emergency application was found to be 4 miles per hour per second with the clasp brake, while with the simple brake it was 3.3 miles per hour per second. At 50 miles an hour the clasp brake gave a deceleration of 3.55 miles per hour per second, while with the standard brake it was 3 miles per hour per second. The length of stop with the clasp brake at 50 miles an hour was 585 ft., while with the simple or standard brake it was 690 ft. This was the average length for about 40 stops.

S. G. Thomson, superintendent of motive power, Philadelphia & Reading, reported excellent service with the clasp brake on both six-wheel and four-wheel trucks on passenger coaches. He suggested that we get along for a few years without the electric brake by extending the use of the clasp brake.

Mr. Sargent suggested that the trouble which had followed the use of flanged brake shoes in connection with increased wheel sliding on some roads, was probably due to the fact that the brake rigging was not suitable for use with this type of shoe. The tests clearly indicate what the flanged shoe will do.

As an illustration of the difference in the requirements that brakes have to meet, Mr. Turner pointed out that in the year 1890 train weights seldom exceeded 280 tons which, with a speed of 60 miles an hour gave an energy to be dissipated of

about 33,000 foot-tons. Brakes used at that time stopped these trains in about 1,000 ft. In the year 1913 the train weight was 920 tons, and at the same speed the energy to be dissipated was 110,000 foot-tons, almost four times as large as that of the train in 1890. With a brake on this train of the same class as that used in the first one, the stopping distance would be 1,760 ft. The collision energy of this train as it passes the point where the first train stopped would still be 48,000 foot-tons, one and one-half times what the first mentioned train had before the brake was applied. The 920-ton train with the new brake apparatus can be stopped when running at a speed of 60 miles an hour in 860 ft., at which point, with the old brake, it would still be running 43 miles an hour. Mr. Turner further stated that while the illustrations no doubt impressed the uninitiated with their complexity and comparative size, when it is realized that the net result as measured by control requirements and stopping distance is but slightly greater in effectiveness than the old brake, it must be admitted that these things must be accepted on the ground that nothing less will suffice if reasonable capacity of track and rolling stock is to be had and general advance in transportation and safety are to keep pace.

NEW BOOKS

Master Car & Locomotive Painters' Proceedings, 1913 Convention. Bound in paper, 132 pages. Size 6 in. x 9 in. Published by the Association, Alfred P. Dane, secretary, Reading, Mass.

The forty-fourth annual convention of the Master Car and Locomotive Painters' Association was held in Ottawa, Ont., September 9 to 12, inclusive. The proceedings contain the report of the test committee, which was of particular importance and interest, as well as papers giving the latest information on the finishing of steel passenger train equipment; safety in the paint department; rough inhibitive paint; protection of steel freight equipment, and economy in locomotive painting. The last mentioned includes a discussion of the present practice in locomotive painting.

Machinery's Handbook. Bound in flexible leather. 4½ in. by 7 in. 1370 pages. Illustrated. Published by the Industrial Press, New York. Price $5.

This is a thoroughly complete reference book on machine design and shop practice intended for the mechanical engineer, draftsman, tool maker and machinist. While it is based largely on the data sheets issued by Machinery and the articles published in that magazine, much additional matter has been included by the compilers, Erik Obert and Franklin G. Jones. It would be impossible, in a review of this kind, to begin to convey an adequate idea of the amount of material contained in this book and it will suffice to say that it is complete so far as machine design and shop practice are concerned. Great pains have been taken to obtain a convenient arrangement of tables, data and text, and the plan of illustrating the use of formulas by examples, which are worked out, has been generally followed. It is believed to contain the best and most condensed treatises on gearing and springs that exist and the sections on heat treatment of steel, properties of material, motor power of machine tools, and screw threads are excellent. The compilers have not overlooked what is probably the most important feature of a book of this kind, a complete and copious index.

Handbook for Machine Designers and Draftsmen. By Frederick A. Halsey, B.M.E., editor emeritus of the American Machinist. 483 pages. 8½ in. by 11 in. Bound in cloth. Illustrated. Published by the McGraw-Hill Book Company, Inc., 239 West 39th street, New York. Price $5.

Mr. Halsey states in the preface that the manner in which contributions to technical journals of permanent value and usefulness form a procession to the limbo of forgotten things and benefit none but those under whose eyes they happen to fall at the date of publication, has always been a source of extreme regret to him. In this volume he has made an effort to rescue from the oblivion of the out of print such contributions as are of direct use in the design of machinery. The search for material has not been limited to periodicals, but has extended to the transactions of many engineering societies wherein information is nearly as effectively buried as in the back numbers of periodicals and, furthermore, he has freely called on the knowledge of many of his friends. It needs but a casual examination of this book to show the accuracy of the author's contentions. While most of it has been published before, it is not until it is collected and classified, as is done here, that the reader is fully impressed with the value of the information. It is, of course, impossible to give here even a fairly clear idea of the material that is included, but, when it is stated that there are 40 different subjects treated, each as a chapter covering from 7 to 38 large pages, it will be appreciated that the scope is broad. These chapters are on subjects of the greatest importance to machine designers and cover such matters as springs, gears, transmissions, clutches, cams, bearings, bolts, nuts, and screws, pipes and pipe joints, balancing, materials, compressed air, mechanics, etc., in addition to a large number of mathematical tables, many of which are not given in the ordinary handbook.

Principles of Industrial Organization. By Dexter S. Kimball, professor of machine design and construction, Sibley College, Cornell University. 268 pages. 6 in. by 9 in. Bound in cloth. Illustrated. Published by McGraw-Hill Book Company, Inc., 239 West 39th street, New York. Price $2.50.

As Professor Kimball truly points out, industry is the business of the civilized world and the greater part of our problem, national, state and home, centers around the great industrial question. Furthermore, it is being looked on as the great basic feature of our civilization on which we must rest our entire well being. With this new evaluation of industry has come new and higher ideals regarding service to humanity. It is for these reasons that the ideas embodied in the so-called scientific management are coming in for such close scrutiny. Changes of similar character and as far reaching in their effects have been made in our industrial methods in times past with little or no comment from any quarter. But today, changes of this character cannot be made as formerly on the basis or plea of increased production alone. The specter of distribution of profits, the bugbear of our industrial system stands constantly in the background, and the question that it ever raises—What will be the effect of these changes on humanity?—can no longer be ignored. It is not the purpose of this book to exploit any form of industrial management or any specific remedy for industrial evil, but it is an endeavor to set before young men entering the industrial field the salient facts regarding the most important movements with which they are sure to be brought in contact and to explain the origin and growth of the important features of industrial organization. To the engineer who is continually being brought more and more in contact with economic problems, these are matters of particular importance. While it is for the needs of young engineers primarily that the book has been written, being based on a course of lectures given by the writer to the senior class at Sibley College of Mechanical Engineering, Cornell University, the practicing engineer or manager who wishes to know something of the fundamental principles of organization, without regard to some specific system of management, will find it also of interest. It has been the writer's endeavor to deal as far as possible with general principles and no effort has been made to illustrate the many kinds of cards and forms used in industrial management. The book contains fourteen chapters, the first four being more or less historical in their nature, and the fifth covering modern industrial tendencies. In other chapters are treated separately the forms of industrial ownership, principles of organization, planning departments, principles of cost keeping, depreciation of wasting assets, compensation of labor, purchasing, storing and inspection of materials, location, arrangement and construction of industrial plants, and the theories of management.

COMMUNICATIONS

JIG FOR GRINDING IN ROTARY VALVES ON E-T EQUIPMENT

CORBIN, Ky., January 10, 1914.

TO THE EDITOR:

I have read with interest Mr. Bentley's article on jigs for grinding in rotary valves on page 42 of the January number. In my experience with this class of work the absence of the valve guide has proved a decided advantage over the older construction where a guide stem is used with the rotary valve, inasmuch as the valve can be moved over the valve seat with a criss-cross motion. I would suggest that the high surface be cut down with a scraper and the criss-cross motion tried. Where the guide is used the valve travels in the same channel all the time and is a source of trouble to repair men unless the surfaces are machine ground or spotted down very closely with a scraper.

J. A. JESSON,
Air Brake Foreman, Louisville & Nashville.

[Mr. Bentley's reply to this criticism is given below.—EDITOR.]

TO THE EDITOR:

As a result of experimenting with a view to saving time on this class of work, I have dropped away from the process of working these valves with face plate and scraper. My method has given a great deal of satisfaction and is, I believe, fully as thorough as the older method. The rotary and valve are faced on a lathe, where the lateral is eliminated as far as possible. With a wooden block on which a strip of fine emery cloth is tacked, the surface is cleared of all tool effects and the valve or seat relieved, to some extent, of the effect of the lighter cut which is always present near the outer portion of circular facing work. This affords a nearly perfect surface and necessitates the use of only a fine grade of grinding compound to bring it to a good seat. With the finer grade compound I have experienced no trouble in the disagreeable occurrence of circular scratching or ridging, and the result of using the guide ring is to assist the bringing of the heavier bearing to the center of the rotary and seat.

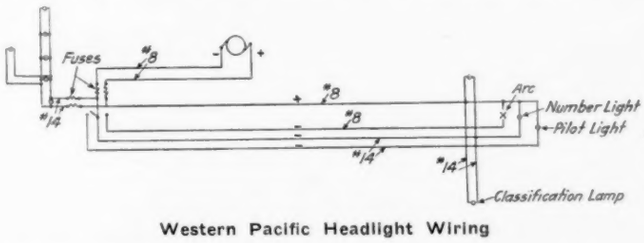
F. W. BENTLEY, JR.

WIRING FOR ELECTRIC HEADLIGHTS

SACRAMENTO, Cal., January 24, 1914.

TO THE EDITOR:

The wiring shown in Fig. 1 of the article on the Installation and Maintenance of Electric Headlight Equipment, by V. T. Kropidlowski, which appeared in the July, 1913, issue of the Railway Age Gazette, Mechanical Edition, will not meet the requirements when it is desired to cut out both the arc and the pilot lamp, as in the case of a train in the clear on a siding



Western Pacific Headlight Wiring

waiting for another train to pass. The reason is that as soon as the switch in the cab is removed from clip 3, the arc lamp carbon will drop and complete the circuit so that the pilot lamp will light immediately without the switch being thrown into clip 1. In order to be able to cut out both the arc and the pilot lamp, it is necessary to run a fourth wire from the pilot lamp to the switch, as shown by the accompanying diagram which is taken from the Western Pacific standard wiring drawing. As the requirement is practically universal that the headlight be extinguished or completely covered when a train is in the clear on a siding, I would suggest that a wiring diagram that will meet the requirements be shown.

W. E. JOHNSTON,
Chief Draftsman, Western Pacific.

[Mr. Kropidlowski's reply to the foregoing letter is given below.—EDITOR.]

WINONA, Minn., February 12, 1914.

TO THE EDITOR:

Concerning Mr. Johnston's criticism of the mode of wiring; when the arc lamp is shut off and the carbons come together there will be a path established to the circuit of the incandescent pilot lamp. It was taken for granted that this would be plain to electrical men and for that reason attention was not drawn to it at the time. Of course, it is understood that this does not provide a solid and permanent contact and the lamp will flicker, owing to the poor contact and the jarring of the locomotive. As to enginemen not being able to extinguish the headlight entirely when waiting on a siding, before the electric headlight was in use they had to get off, climb on the pilot beam and cover the face of the lamp with a cover provided for the purpose. With the electric equipment the fireman can step out on the running board, raise one of the generator brushes and place a small chip of wood between the brush and the commutator, which is certainly easier than the old way. I believe that the simplifying of the wiring, which is one of the biggest factors in reducing troubles and failures, and is also effective in trying to locate trouble in the system, more than offsets the little inconvenience of one of the enginemen's having to step out on the running board when in a siding to meet a train.

V. T. KROPIDLOWSKI.

COLLEGE MEN AND THE RAILROADS

R——, Pa., January 3, 1914.

TO THE EDITOR:

I have read with mingled pleasure and regret, the several articles appearing in recent issues of your publication, under the heading, "College Men and the Railroads," and, as I believe that much of the discussion and some of the conclusions are not justified, and that, in the main, injustice is done the unfortunate "college man," I feel in duty bound to assist in the removal of prejudice, against him, which prejudice, however, I am confident, will have disappeared entirely within the next score of years.

What is a "college man"? Is he constructed of a different clay, or was his life up to the age of 18 years materially different from that of others? At college he associated with several hundred young men of approximately his own age, during a portion of each of four consecutive years. During this time he certainly got some good bumps from his fellows. He must have done a large amount of work requiring mental effort, thus developing his mental capacity, either memory or reasoning powers or both, and in some courses he must have had a varied and valuable, though brief, shop and mechanical laboratory experience in connection with the class room work. Can he then leave college so utterly worthless as some men who have not attended college would have every one believe?

I think that the average college trained man is handicapped by his experience at college, not because he thinks he has learned it all or considers himself superior, but quite on the contrary, because he has been thoroughly impressed with the fact that all he knows or ever can know, is but an infinitesimal part of what there is to learn.

His brother who ran a nut tapping machine for a year, turned up bolts another year, ran a planer or shaper, possibly helped put up cab fittings, a steam chest or two, and if especially favored, helped lay out a few sets of shoes and wedges during the final two years of his shop apprenticeship, has, because of his narrow horizon, frequently developed a most thoroughly exaggerated ego; he has confidence in himself to the ends of his small earth and momentarily is of more value than the col-

lege man. The swelled heads unfortunately are not all on the shoulders of the men from the universities.

I believe the causes for failure of college men, not applicable to non-college men, are, in order of their importance: (1) The narrow, distorted, egotistical old-time managers who are fast disappearing. (2) The lack of force on the part of the college man, due to his thorough knowledge that he knows so little. (3) The "molly-coddling" some young men receive before and while at college.

Let us stop making a distinction between so-called college and non-college men. That an individual has undergone the training required in higher educational institutions does not insure that he is better equipped to fight life's battles in general or in particular than is his brother who may not have had such advantages, but who may have inherited a brain of greater capacity, or who has accomplished greater development by study outside school walls.

Special apprentice courses should be open to non-college, as well as college, men. I prefer an educated jack ass to an uneducated one and believe that the "wonder" who never saw the inside of a school house would have been a greater wonder if he had. W.

Chicago, Ill., October 21, 1913.

To the Editor:

The article appearing in the October issue, signed I. I. W., puts the cart before the horse. Instead of "why don't the railroads hold the college man?" the question should be "why doesn't the college man stay with the railroads?"

The best of the college men who enter the railroad service do stay and those who enter the service and leave in the earlier stage of the fight, leave for several reasons:

First, many of the special apprentices have contracted debts in order to get through college and even after they have begun their apprenticeships, often quit and go in search of work which will be more remunerative, at least for the time being, in order that they may make sufficient money to liquidate their bills.

Second, the average college man is unwilling to start at the bottom and work up. He thinks that immediately after serving his apprenticeship an official positon should be given him. The railroads are not in the habit these days of entrusting the management of their shops or roundhouses to men without considerable practical experience, together with a distinct showing for leadership or evidence of executive ability. These qualifications are not always possessed by college graduates.

Third, the college graduates are not satisfied with what they deem the low rate paid by railroads for special apprentices, thought, in fact, it is what the railroads think special apprentices are worth. Very few railroads are able or willing to pay a man more than he is worth for any length of time. The complaint of the college man that the railroads do not give the special apprentice a chance, is a cry of the weak and undeserving. We generally find out that where an ordinary journeyman apprentice makes a complaint that he is not being given a show, he is not entitled to much of a show, that there is something in his make-up which tends to prevent the shop authorities from especially exerting themselves in his behalf. If he is a bright, active, aggressive apprentice, he does not make this cry. He goes ahead and attends to his work and the opportunities will come to him. The great trouble is with the colleges, as none of our universities and colleges ever take the pains to study the student's make-up, or ever go to the trouble of ascertaining his fitness for the course he is studying. Often he goes into it because somebody, a friend, or sometimes a relative, has suggested it to him. Consequently we have hundreds of graduates from our technical schools in mechanical engineering, who really have no talent or love for engineering work. These men will never be satisfied, regardless of the work or position given them. The majority of our schools spend too much energy getting students, and none decrease their enrollment by advising young men to discontinue the course they have selected. I am not ready to believe that all the other special apprentices who go into commercial fields make such a howling success. It is true that the commercial field requires men who are technically educated, to a greater extent than do railroads. With the exception of the mechanical engineer, engineer of tests and chemist, there is no absolute necessity for the other officials in the mechanical department to be college men. In fact, one of the largest and most prosperous western roads has not a single master mechanic who has had a college education.

The college man is usually unwilling to begin at the bottom, although he is perfectly willing to do any special work and glad to work in the test department, but the special apprentice who serves most of his time in the drafting room and with the engineer of tests, will be up against it if placed in charge of a large roundhouse. At the same time he is unwilling to go into a roundhouse and work as a journeyman and familiarize himself with the needs and requirements of such a place. In fact, the writer knows of an instance of a special apprentice who was graduated from one of the large eastern colleges, who, in conversation with another special apprentice that had completed his apprenticeship and was climbing up the ladder, remarked that he only had two months before his apprenticeship would be completed and would be awfully glad of the time when he could get out of wearing overalls and doing dirty work. Now this young man had an idea that as soon as he completed his apprenticeship a master mechanicship awaited him. The road on which this young man was serving his time was giving him every opportunity to acquire the practical work and to show what stuff was in him.

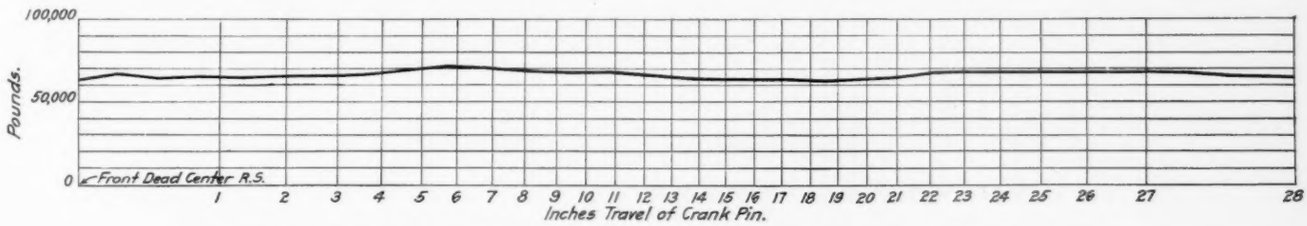
Very few foremanships, these days, are made through pull, and even if made that way, the man must have some merit in order to hold the job. I am sure wherever a special apprentice will show that he has merit he will have just as good chances of promotion from the ranks as the ordinary journeyman apprentice. The writer does not know of a single instance where a man has been promoted from the ranks to a master mechanic's position at one jump and succeeded. Gang, back shop and roundhouse foremen are absolutely necessary training for the master mechanicship, and it is these minor positions which the special apprentices object to filling.

It is unnatural and unreasonable to ask the railroads to provide separate machines and special instructors for the few special apprentices. The expense would be prohibitive and the results fruitless. Such a proposition is in keeping with the average college graduate. He expects things to be done solely for his own good, and thinks that he is better than others and should receive special treatment. Such a scheme would produce a most undesirable caste. To be a successful foreman or official in any department the man must be a mixer, he must know the men in the ranks, their methods, their ways, their shop language. He must know how to do the work himself. This is the reason why the machinist who served his regular apprenticeship generally makes the best foreman. The college man under similar conditions with the advantages of a technical education, and his reasoning faculties more largely developed, should on paper make the best official, but we do not find this the case in actual practice. There are no men or set of men who need a pull more than the college man and there is no one so pitifully helpless as the college man in a modern shop. There is not a single school in the country that can graduate a master mechanic, fit him for the job, ready to go on duty the day he receives his diploma. West Point and Annapolis are the two schools in this country which graduate the officer. But look what they must pass through during the four years. No man requiring the attention of a surgeon will trust his case in the hands of an M. D. who graduated one hour ago. Nor will he entrust his legal affairs to one just admitted to the bar. These young M. D.'s and B. L.'s must serve an apprenticeship in a hospital or law office of older heads. We are glad to get college men, but we are unwilling to nurse them any more than the sixteen-year-old boy with only a sixth grade common school education. An Old College Man.

LEHIGH VALLEY PACIFIC TYPE LOCOMOTIVE

Anthracite Burning Passenger Engines for Heavy Grade Work; Valve Setting Given Close Study

The Lehigh Valley recently designed a heavy Pacific type superheater locomotive and has placed six of them in passenger service on the division between Easton, Pa., and Sayre, Pa., a distance of 194 miles. The maximum grade on this division is between Mauch Chunk and Wilkes-Barre, Pa., over the Wilkes-Barre mountain. The grade between Mauch Chunk and Glen Summit (the top of the mountain) is 33.7 miles long, and has a maximum rise of 67 ft. to the mile, westbound. The grade between Wilkes-Barre and Glen Summit is 19.6 miles long with a maximum of 95.7 ft. to the mile eastbound. A profile of this section is shown in one of the illustrations.



Turning Effort at the Crank Pin for a Full Stroke; The Effect of Both Cylinders is Considered

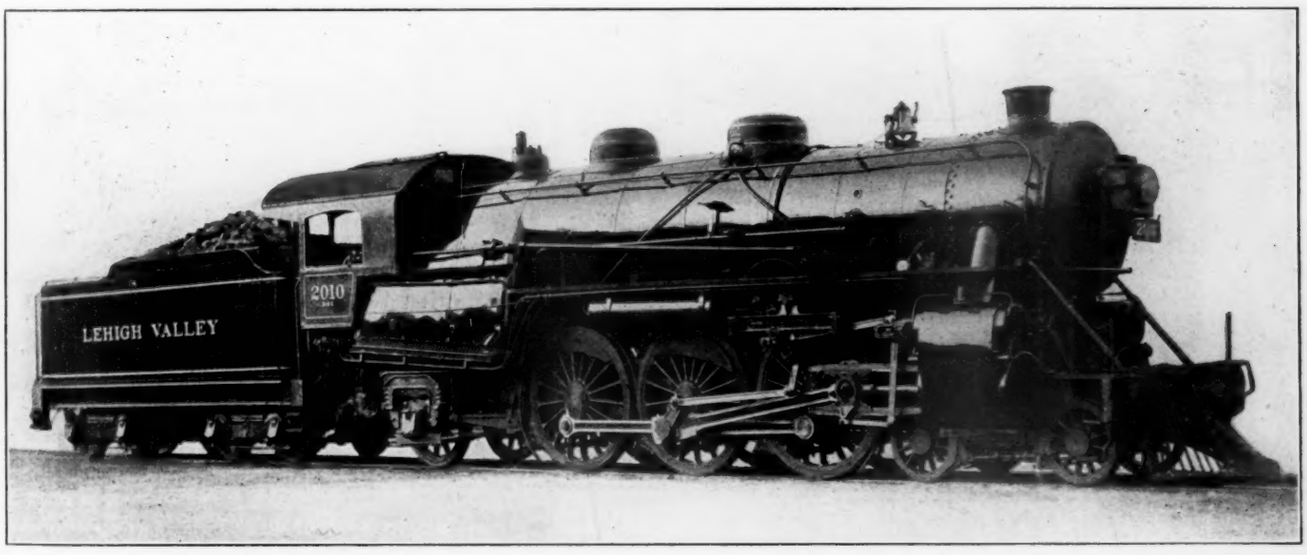
These locomotives were designed to haul, unassisted, passenger trains weighing 550 tons westbound, and trains of 360 tons eastbound, over this division. Heretofore it has been necessary to double head trains of these weights over this portion of the road, using a Pacific type locomotive having a total weight of 241,300 lb. and a tractive effort of 31,600 lb., and a ten-wheel helping locomotive having a total weight of 199,500 lb. and a tractive effort of 31,400 lb.

The new Pacific type has a total weight of 262,000 lb. and a tractive effort of 41,500 lb., the factor of adhesion being 3.89. The total evaporative heating surface is 3,744 sq. ft. and, making the usual allowance for the superheater, the total equivalent heating surface is 4,962 sq. ft. This gives 8.35 lb. theoretical tractive effort per pound of equivalent heating surface.

Special attention was given to the details of design, in order to obtain the maximum tractive effort at high speeds per pound total weight of locomotive. On account of the low factor of adhesion it was necessary to design the valve gear to obtain a rotative effort as nearly constant as possible, thereby keeping the factor of adhesion very close to the theoretical. How well this has been accomplished is illustrated by the torsional diagram combining both cylinders when developing 2,100 indicated horsepower with a cut-off of 66 per cent at 148 revolutions per minute. It will be seen that the turning effort is practically uniform for the full revolution.

Piston valves 14 in. in diameter are driven by Walschaert valve gear. The valves have a travel of 6 in., a steam lap of 1¼ in., an exhaust clearance of ⅛ in. and a lead of 5/16 in. The large amount of lap is apparently responsible for the even turning movement.

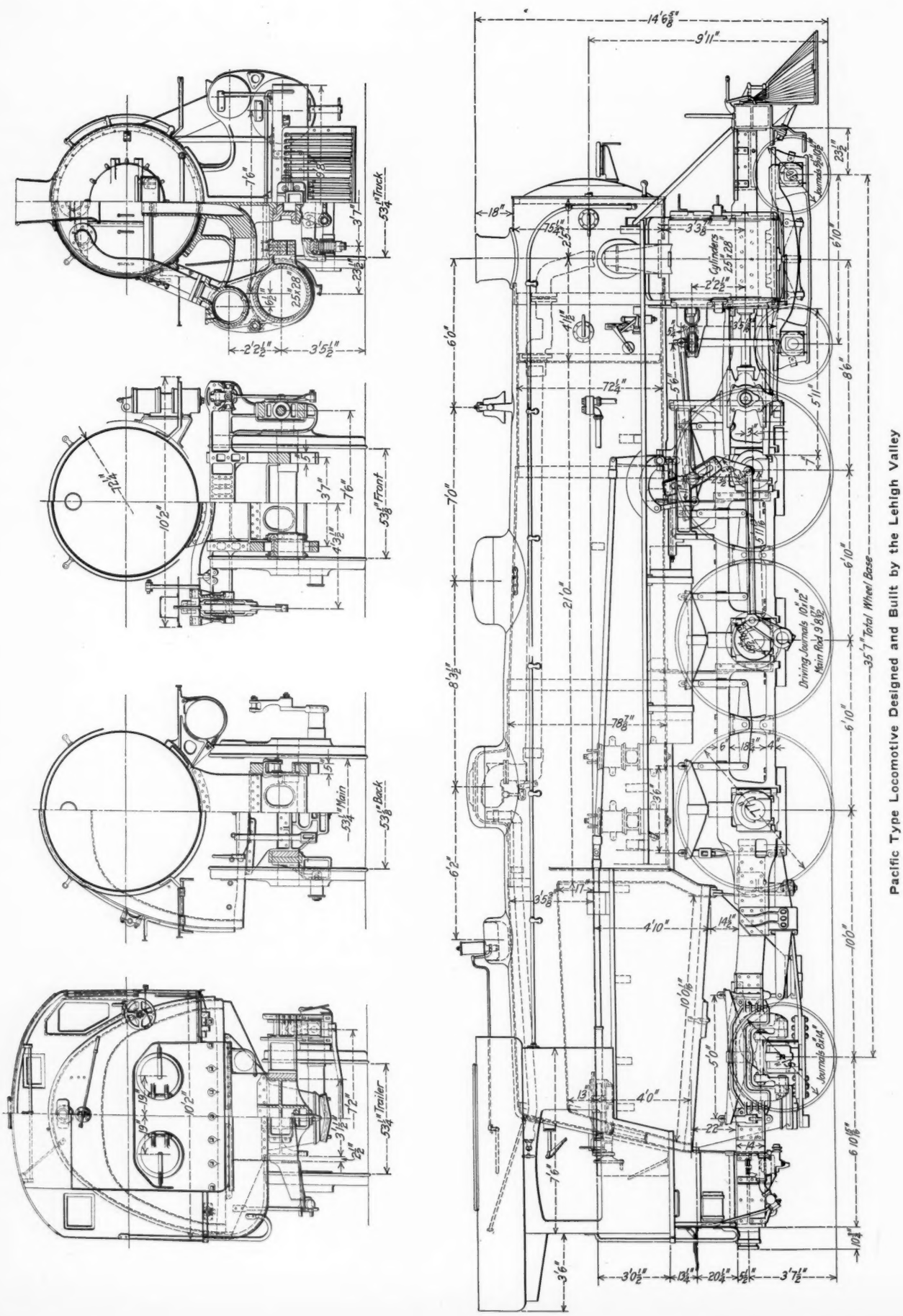
A screw reverse gear is applied, and on account of the extreme width of the firebox it will be noted that it was necessary to insert a universal joint in the reach rod just ahead of the bearing at the front end of the firebox.



Passenger Locomotive for Service on Heavy Grades on the Lehigh Valley

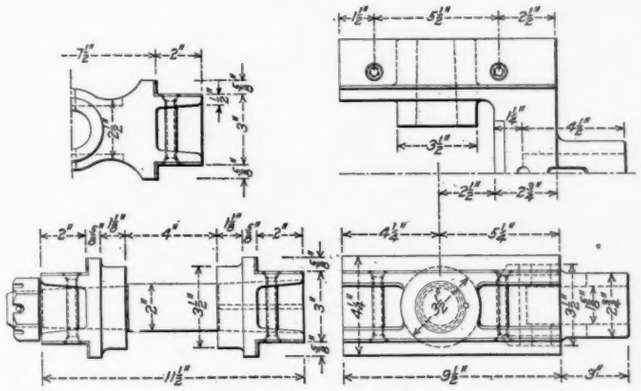
One of the interesting features of the valve gear is the valve stem crosshead, which is of the self-centering type and is so constructed that the pin is provided with a nut. This is unusual in this type of crosshead, and permits the pin to be removed without taking down the crosshead. This detail is shown in one of the illustrations.

The side rods are of the semi-I section having a flange 1¾ in. in width and 1⅜ in. in depth at the center of the rod,



Pacific Type Locomotive Designed and Built by the Lehigh Valley

while the web is ½ in. thick and 3¼ in. deep for the back connection and the same thickness and a varying depth for the front rod. The back rod is of uniform section for its length while the rod connecting the main with the front driver is 8 in. in total depth at the beginning of the flanged section



Valve Stem Crosshead of the Lehigh Valley 4-6-2 Type Locomotive

and 6 in. at the front end. The rods are 4½ in. in width at the pin.

The tender cistern construction was fully illustrated on page 72 of the February issue of this journal. It follows a new departure which requires the top and bottom sheets of the cistern to be flanged and riveted to the side and end sheets, thus eliminating the angle iron connection and all rivet holes through the bottom of the cistern. This construction not only reduces the first cost, but also gives a lower cost of maintenance.

That these locomotives are doing all that was expected of them is illustrated by the speed chart performance while hauling the Black Diamond Express between South Bethlehem, Pa., and Wilkes-Barre, Pa. This is an all steel parlor car train consisting of eight cars, weighing 603 tons behind the tender, exclusive of baggage and passengers.

Following is the general data and proportions of these locomotives:

General Data

Gage	4 ft. 8½ in.
Service	Passenger
Fuel	Anthracite
Tractive effort	41,597 lb.
Weight in working order	262,160 lb.
Weight on drivers	161,940 lb.
Weight on leading truck	49,420 lb.
Weight on trailing truck	50,800 lb.
Weight of engine and tender in working order	404,860 lb.
Wheel base, driving	13 ft. 8 in.
Wheel base, engine and tender	76 ft. 4⅛ in.

Ratios.

Weight on drivers ÷ tractive effort	3.89
Total weight ÷ tractive effort	6.30
Tractive effort × diam. drivers ÷ equivalent heating surface*	642.00
Total equivalent heating surface ÷ grate area	56.80
Firebox heating surface ÷ total saturated heating surface, per cent	6.00
Weight on drivers ÷ total equivalent heating surface	32.60
Total weight ÷ total equivalent heating surface*	52.80
Volume both cylinders, cu. ft.	15.90
Total equivalent heating surface* ÷ vol. cylinders	310.00
Grate area ÷ vol. cylinders	5.50

Cylinders.

Kind	Simple
Diameter and stroke	25 in. x 28 in.

Valves.

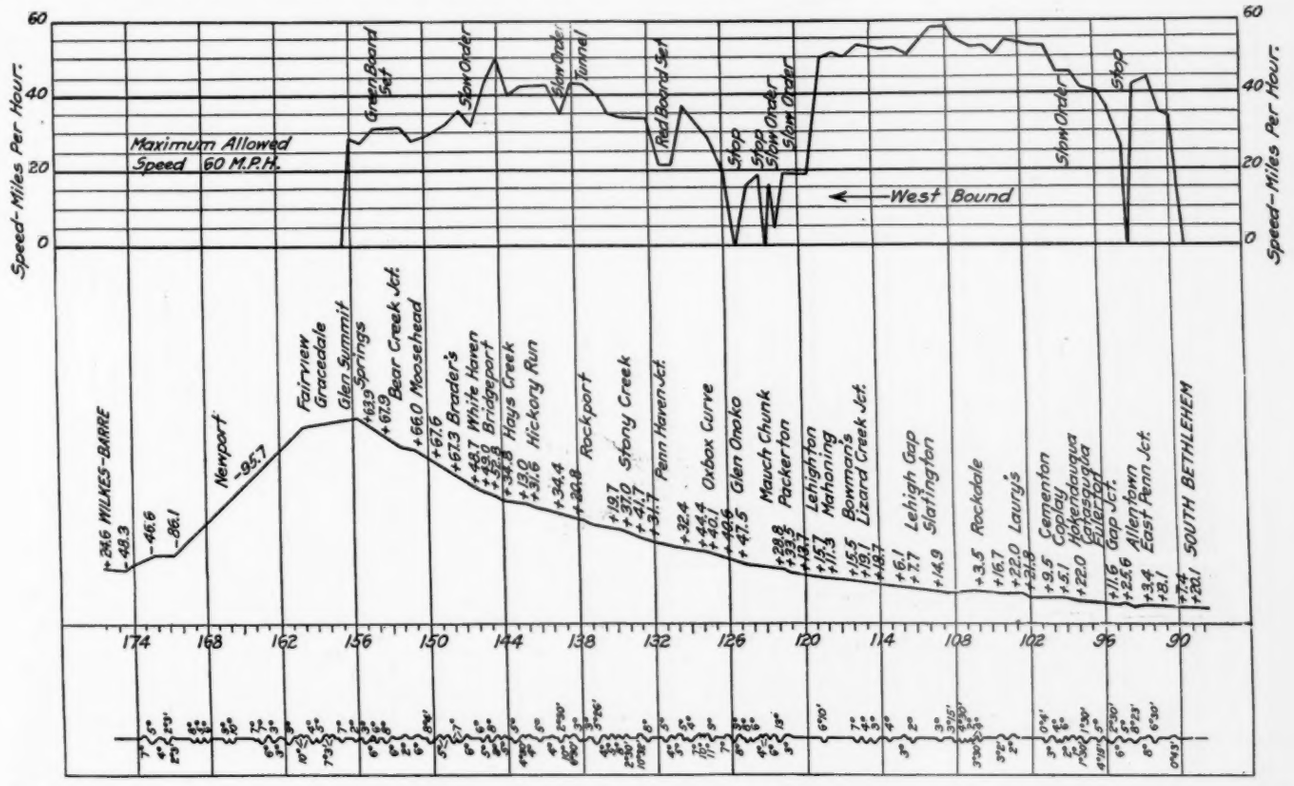
Kind	Piston
Diameter	14 in.
Greatest travel	6 in.
Steam lap	1¼ in.
Exhaust clearance	⅛ in.
Lead	5/16 in. constant

Wheels.

Driving, diameter over tires	77 in.
Driving journals, main	10 in. x 18 in.
Driving journals, others	10 in. x 12 in.
Engine truck wheels, diameter	36 in.
Engine truck journals	5½ in. x 10½ in.
Trailing truck wheels, diameter	51 in.
Trailing truck journals	8 in. x 14 in.

Boiler.

Style	Wooten
Steam pressure	215 lb.



Profile of Lehigh Valley from South Bethlehem to Wilkes-Barre; The Upper Curve is a Speed Chart of the Eight Car Train (603 tons) Drawn by One of the New Pacific Type Locomotives

Outside diameter of first ring	72¼ in.
Firebox, length and width	126⅛ x 104⅝ in.
Firebox plates, thickness	⅜ in.
Firebox, water space	F., 4½ in.; S. & B., 3½ in.
Tubes, number and outside diameter	234—2 in.
Flues, number and outside diameter	32—5⅜ in.
Tubes, length	21 ft.
Heating surface, tubes	3,519 sq. ft.
Heating surface, firebox	225 sq. ft.
Heating surface, total, evaporating	3,744 sq. ft.
Superheater heating surface	812 sq. ft.
Total equivalent heating surface*	4,962 sq. ft.
Grate area	87 sq. ft.
Smoke stack height above rail	14 ft. 6⅝ in.

Tender.

Frame	13 in. channel
Wheels, diameter	36 in.
Journals, diameter and length	5½ in. x 10 in.
Water capacity	7,000 gallons.
Coal capacity	12 tons

* Equivalent heating surface = evaporative heating surface + 1½ times superheater heating surface.

ADVANTAGES OF LOGARITHMIC CO-ORDINATE PAPER

BY TOWSON PRICE

Although logarithmic coordinate paper is of comparatively recent origin and has a comparatively small field of use, there are several important advantages which it has over ordinary coordinate paper, that are well worth noting.

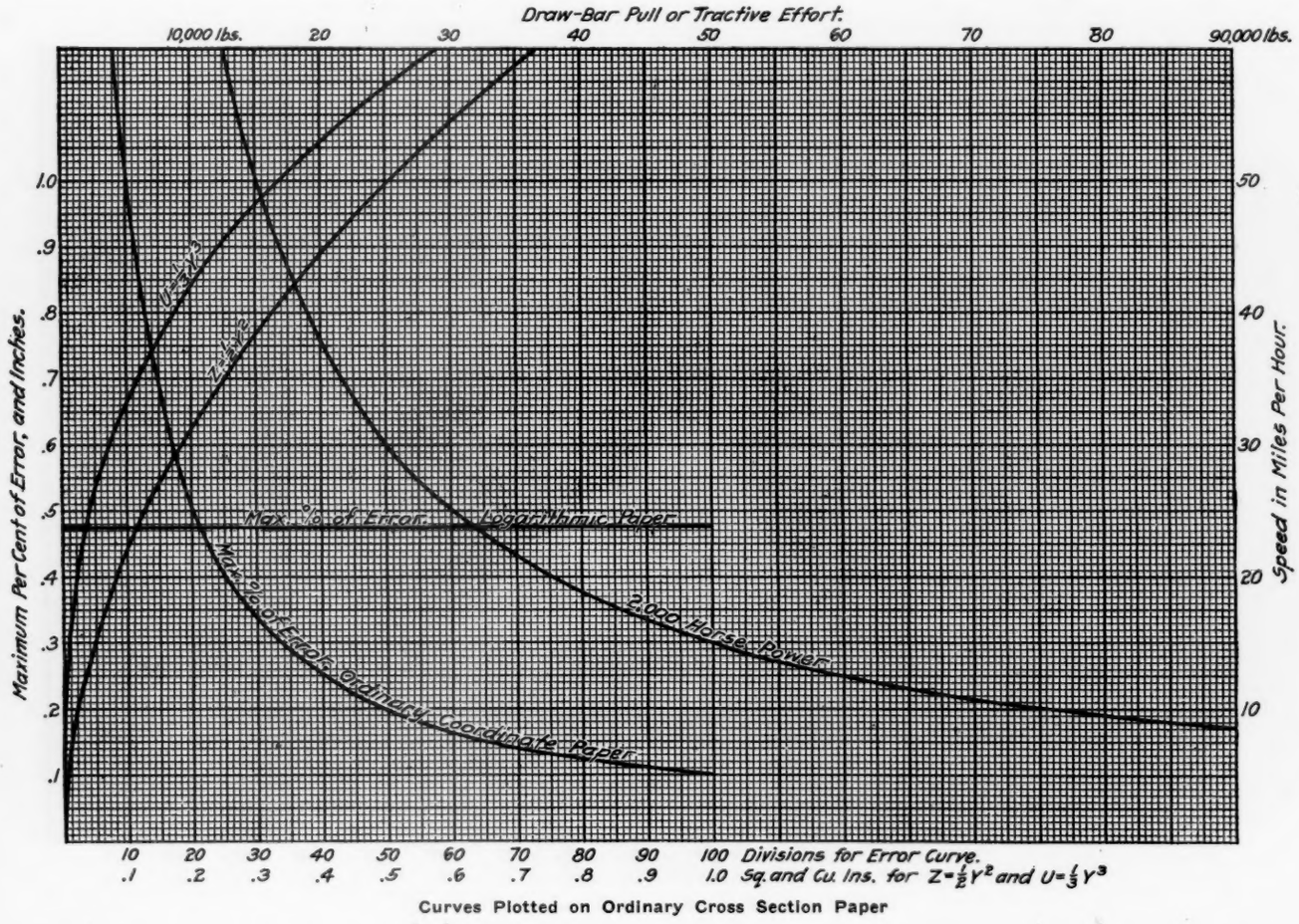
There are two grades of logarithmic paper, as sold by Keuffel & Esser, one on which the divisions of the 10 in. square are from 1 to 10, corresponding to the lower scale divisions of an ordinary 10 in. slide rule. The other is on translucent paper, suitable for blue printing, and is divided into four 5 in. squares, the divisions corresponding to those of the upper scale of an ordinary 10 in. slide rule.

Let us consider the relative accuracy of making use of a chart on the latter variety of paper compared with that of the same chart on ordinary coordinate paper. To make a fair comparison, assume a 10 in. square of ordinary paper, whose sides are divided into 100 equal parts. Each division equals .1 in. Assume that it is possible to read within .01 in. or .1 of a division. Then the accuracy of using the chart, say at 75, is with less than .1 ÷ 75 = .133 per cent. of error. At 10 the error is less than .1 ÷ 10 = 1.0 per cent. In other words, the error increases as we approach the origin.

Consider the corresponding logarithmic paper. At 75, .01 in. equals .357 of a division. The error is less than .357 ÷ 75 = .476 per cent. At 10, .01 in. equals .0476 of a division. The error is less than .0476 ÷ 10 = .476 per cent. In other words, there is always a uniform percentage of accuracy for all parts of a chart on this kind of paper. This is no small advantage, as it makes it possible to condense charts and still obtain the required accuracy.

One of the most useful purposes of logarithmic paper is the representation of formulas, which are curves on ordinary coordinate paper but straight lines on logarithmic paper. Thus, all equilateral hyperbolas in the form $xy = c$ are straight lines on this paper. Also steam engine and gas engine curves in the form $PV^n = C$ are all straight lines. The application of logarithmic paper in the analysis of the cylinder performance of reciprocating engines is dealt with by J. Paul Clayton in bulletin No. 58 of the Engineering Experiment Station of the University of Illinois. This bulletin shows how to transfer indicator diagrams to logarithmic paper, determine cylinder clearance and leakage, and find the value of n in $PV^n = C$. These are only a few of the uses of this paper. All expressions of the form $y = x^2$, $cx = y^n$, etc., are straight lines on logarithmic paper.

L. R. Pomeroy has made frequent use of logarithmic paper in constructing many of the charts which have appeared in the



Curves Plotted on Ordinary Cross Section Paper

Railway Age Gazette, Mechanical Edition, as far example on page 436, of the August, 1913, issue.

Suppose that we wish to prepare a chart for quickly finding the approximate horsepower a locomotive is developing for the known draw bar pulls and speeds on a dynamometer test.

Let HP = horsepower, F = tractive effort or draw bar pull in pounds, and V = speed in miles per hour. Then HP = FV ÷ 375. A series of horsepower lines on ordinary rectangular cross section paper would be a series of hyperbolas, as this equation is of the form xy = c, x = F, y = V, and c = 375HP. It would be a laborious task to construct a large number of these; also they would not be very accurate unless a considerable number of points were plotted for each. On logarithmic paper, on the contrary, these horsepower lines are all straight and parallel to each other, making angles of 45 deg. with the axes. This makes it necessary to find only one point for each line to make the chart as shown.

To make this chart it is only necessary with logarithmic paper to plot two points for each of the equations $Z = \frac{1}{2}Y^2$ and $U = \frac{1}{3}Y^3$. Thus, draw a straight line through the points .2, .02 and .4, .08 for the first and one through the points .3, .009 and .6, .072 for the second. This chart could be used as it stands, or it could be used to prepare a nomogram similar to that on page 381 of the August 29, 1913, issue of the Railway Age Gazette. If a chart to represent these equations were made on ordinary cross section paper, a series of points would have to be found for each of the equations and curves drawn through these points, as shown.

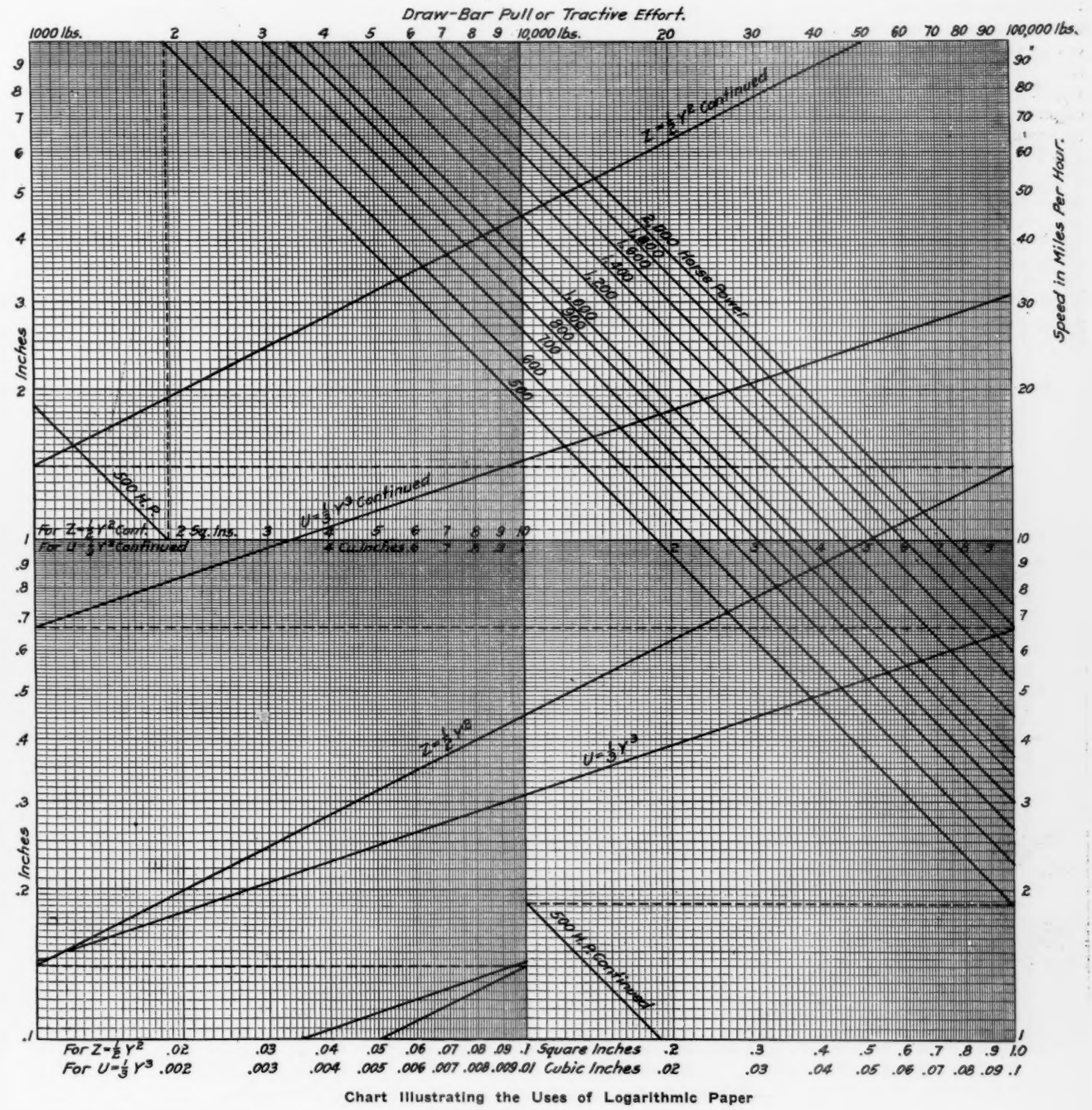


Chart Illustrating the Uses of Logarithmic Paper

Mr. Pomeroy's tractive effort chart, in the Railway Age Gazette, Mechanical Edition, August, 1913, page 436, is a combination of graphical division and multiplication, for which purpose logarithmic paper is ideal. Another advantage of this paper is the ease with which the lines may be continued, as indicated on the chart.

REINFORCED CONCRETE COALING STATION

Reinforced concrete has a number of advantages as a material for locomotive coaling stations. This is especially true where the mechanical type of station is selected and the ground area occupied is comparatively small. A large number of recent stations of this kind, that have been erected at various points throughout the country, have been built of this material and so far have seemed to develop very few disadvantages.

Among the recent reinforced concrete coaling stations which can be taken as a good example of the latest design and construction, is one erected for the Indiana Harbor Belt Railway at Blue Island, Ill. This station, while not as large as some others, is about the average size for an ordinary terminal where two coaling tracks are sufficient.

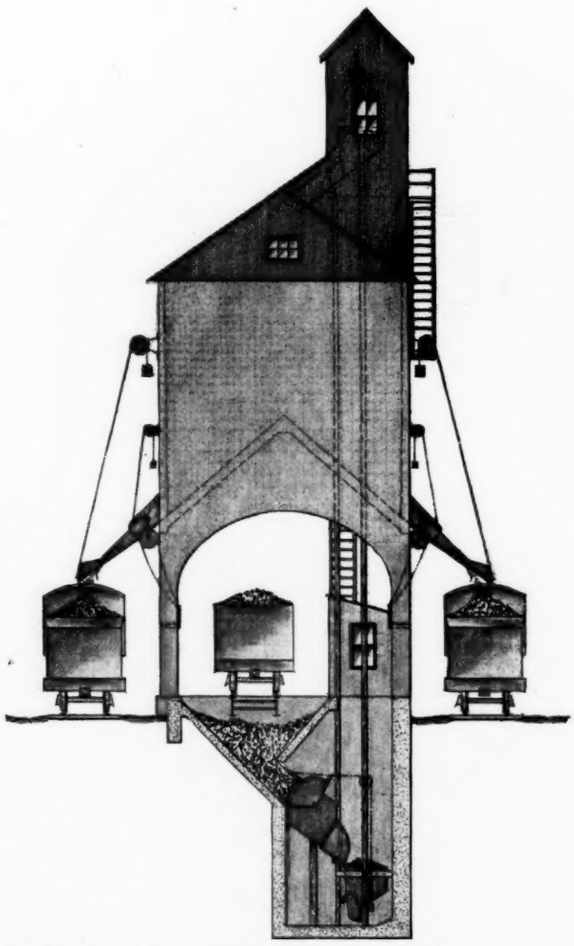
It has a storage capacity of 500 tons in the pocket and an elevating capacity of 75 tons an hour. The station is entirely automatic as regards the elevation of the coal to the pocket and is electrically driven. As will be seen in the illustrations, the coal is received on a center track passing beneath the pocket and is discharged to a hopper under the track. The hopper is 30 ft. in length and is designed with a slope of 40 deg. It leads

Reinforced Concrete Coaling Station at Blue Island, Ill.

to a measuring feeder and is entirely self-clearing. The feeder is automatic in its operation and is actuated by the ascent and descent of the Holmen type elevating bucket which passes up a shaft through the pocket.

The pocket is supported on eight reinforced concrete columns, the center supports being 18 in. by 24 in. in section and the end columns 14 in. by 24 in. in section. The pocket is 45 ft. 8 in. high over all and is 33 ft. in length by 28 ft. wide. All the concrete used is mixed in the proportion of 1-2-4, and the reinforcing rods are of the corrugated section. The bucket tower and the canopy over the pocket are of structural steel and the operator's hoist house on the ground level is of the same material. The outside covering of these structures is of rust-resisting galvanized American ingot iron.

The single elevating bucket is arranged with a 6-in. roller on



Section Showing Arrangement and Location of Hoisting Apparatus

the apron, which travels on a continuous steel guide from the bottom of the pit to the bucket discharge point. This positively assures the closing of the bucket at all times in its travel, except when discharging coal at the top. It is carried by a 7/8-in. special hoisting cable which passes over a 40-in. diameter sheave at the top and continues downward around the drum of the electric hoist and then to the counterweight which balances the load. The hoist is equipped with Falk patented herringbone steel gears and is direct connected to a 22 horse power, crane type, electric motor. This motor is equipped with a solenoid brake mounted on one end of the motor shaft to prevent the dropping of the bucket in case the current is cut off. An automatic bucket hoist control with treadle switches permits the automatic operation of the elevating process without any attention from the operator. This station is equipped with four sets of improved rack and pinion undercut gates which are manually operated and do not depend on counterweights for closing. The flow of coal is cut off from underneath and the aprons are made of 3/16 in. and 1/4 in. steel plate, properly reinforced with angles and equipped with hoods to deflect the coal directly to the tender.

This station was designed and erected by the Roberts & Schaefer Co., Chicago, Ill.

STRENGTH OF LOCOMOTIVE BOILERS

Discussion of the Features to Be Considered in Filling Out Reports to the Federal Board

BY WM. N. ALLMAN

The strength of locomotive boilers has been given much study, more particularly during the past few years, largely because of the act of Congress, approved February 11, 1911, and the formation of different state boiler commissions.

The filling in of the specification cards has meant considerable labor, especially where a road has many different classes of locomotives. In such cases, the various boilers must be stripped and measurements taken as a preliminary to making the various calculations.

The writer has prepared a number of simple formulas based on well established and authorized rules, which can be used in determining the different stresses, as called for on the forms required by the Interstate Commerce Commission and the various state boiler commissions. These forms are identical in many respects.

Boiler form No. 4, for the Interstate Commerce Commission, requires something more than merely filling out existing records, covering such items as the different appurtenances, dimensions and the tensile strength of the shell plates. Careful calculations must be made to determine the strength of the different parts. The stresses required on this form are: Calculated efficiency of the weakest longitudinal seam; maximum stress in the staybolts at the smallest section; maximum stress in the staybolts at the root of the thread; maximum stress in the crown bar rivets at the root of the thread, or smallest section, top and bottom; maximum stress in round and rectangular braces; maximum stress in the gusset braces; shearing stress in the rivets, and the tension on the net section of the plate in the longitudinal seam having the lowest efficiency.

FAILURE OF RIVETED JOINTS

The first thing to be determined is the strength of the different seams, both longitudinal and circumferential. It is necessary to calculate each of the seams. In connection with the failure of riveted joints, there are five modes of failure that will be considered as follows: Shearing of the rivets; tearing of the plate along the line of rivets; tearing of the plate between the rivet hole and the edge of the plate and the shearing of the rivet; crushing of the rivet or plate in front of the rivet and the shearing of one rivet; rivet shearing out of the plate in front of it and the shearing of one rivet.

The two by which the joints generally fail are the shearing of the rivets or the tearing of the plate along the line of rivets. The others generally give a higher efficiency.

The shearing value of rivets in single and double shear, as specified in the rules and instructions for the inspection and testing of locomotive boilers and their appurtenances, issued by the Interstate Commerce Commission, specifies a value in double shear to be equal to double that of single shear, these values being as follows:

Iron rivets in single shear.....38,000 lb.
Iron rivets in double shear.....76,000 lb.
Steel rivets in single shear.....44,000 lb.
Steel rivets in double shear.....88,000 lb.

The table given below serves to illustrate the value of the shearing strength of rivets as used by several large builders of boilers, and also as given by different authorities.

Resistance to Shearing; lb. per sq. in.				Relative value double to single shear		Value based on driven or initial size of rivets	Authority.
Single Shear		Double Shear					
Iron	Steel	Iron	Steel	Iron	Steel		
38,000	.....	76,000	.....	2	....	Driven	Railway Master Mechanics' Association.
38,000	44,000	76,000	88,000	2	2	.....	Proposed Government Rules. Adopted June 2, 1911.
41,000	47,000	82,000	94,000	2	2	Driven	W. C. Unwin.
.....	.....	.....	.....	2	2	.....	Thurston, R. H. "Manual of Steam Boilers."
50,000	.....	.....	.....	2	2	.....	Weisbach, Julius. "Theoretical Mechanics."
.....	.....	.....	.....	....	2	.....	Cambria Steel Company.
.....	50,000	.....	.....	....	2	.....	Carnegie Steel Company.
.....	Note	.....	.....	....	2	.....	Bureau Veritas (French).
40,000	49,000	78,000	84,000	1.95	1.71	Driven	Master Steam Boiler Makers' Association, 1905.
.....	.....	.....	.....	....	2	.....	Engineering Department, B. & O. R. R
.....	Note	.....	.....	....	*1.75	.....	British Lloyds.
40,000	50,000	.....	.....	....	....	.....	Pencoyd Iron Works.
40,000	†	.....	.....	....	....	.....	National Tube Company.
40,000	49,000	74,000	84,000	1.85	1.85	Driven	The Baldwin Locomotive Works.
38,000	42,000	70,000	78,000	1.84	1.86	Driven	Board of Boiler Rules of Massachusetts.
38,000	42,000	70,000	78,000	1.84	1.86	Driven	Hartford Steam Boiler Inspection and Insurance Company.
.....	48,000	.....	72,000	....	1.75	Driven	Maryland Steel Company.
.....	Not specified—Rivets proportioned to thickness of plates.					.....	Board of Supervising Inspectors, U. S.
.....	46,000	.....	80,500	....	1.75	.....	British Board of Trade.
.....	Note	.....	.....	....	....	Driven	German Lloyds.
40,000	.....	75,300	.....	1.85	....	Driven	Philadelphia Rules.
.....	.....	.....	.....	1.75	1.75	Driven	American Locomotive Company.
.....	.....	.....	.....	1.75	1.75	Initial	Public Service Commission, New York.
40,700	.....	75,300	.....	1.85	....	.....	Shock (Chief Engineer Naval Academy).
.....	50,000	.....	.....	....	....	.....	Kennedy, Alex. B. W. (Test made for British Inst. of Mech. Eng.)

NOTE.—85 per cent. of the tensile strength of the plate.
* Where experiments have been made.
† 43,000 lb. to 68,000 lb.

Table 1 gives the value of rivets in single shear and covers a range in shearing strength from 38,000 lb. to 50,000 lb., the driven rivet or rivet hole being based on 1/16 in. larger diameter than the initial size of the rivet.

Table 2 gives similar information for rivets in double shear, the value being 1¾ times that of single shear. If it is desired to base the value equal to two, the figures shown in Table 1 can be doubled. While, as mentioned above, the Interstate Commerce Commission allows a value for rivets in double shear equal to twice that of single shear, it is the practice of some of the state boiler commissions to allow a maximum value of 1¾.

To supply the information called for on boiler form No. 4, the first step is to ascertain the efficiency of the seams. The rules adopted by the Railway Master Mechanics' Association in 1895 cover the five methods of failure for a riveted joint; the first two mentioned above, generally give the weakest condition. There are cases, however, where the joint may be weaker under

either of the other three conditions mentioned, especially in connection with boilers built a number of years ago, when the boiler foreman was the designer as well as the builder. Now that this work is generally performed by skilled designers, standard practices are followed and standard seams are established. It may be necessary, therefore, in many instances to figure at

TABLE 1—SHEARING VALUE OF RIVETS (DRIVEN SIZE)

Single Shear

Diameter of Rivet.	Driven Rivet or Rivet Hole		Ultimate Shearing Strength (Lb. per Sq. In.)											
Inches	Diameter, Inches	Area, Sq. In.	38,000	39,000	40,000	41,000	42,000	43,000	44,000	45,000	46,000	47,000	48,000	49,000	50,000
1/2	9/16	.2485	9,443	9,691	9,940	10,188	10,437	10,685	10,934	11,182	11,431	11,679	11,927	12,175	12,425
9/16	5/8	.3068	11,658	11,965	12,272	12,578	12,886	13,192	13,499	13,806	14,113	14,420	14,727	15,033	15,340
5/8	11/16	.3712	14,106	14,477	14,848	15,219	15,590	15,961	16,333	16,704	17,075	17,446	17,817	18,189	18,560
11/16	3/4	.4418	16,788	17,230	17,672	18,144	18,556	18,998	19,439	19,881	20,323	20,765	21,207	21,649	22,090
3/4	13/16	.5185	19,703	20,221	20,740	21,258	21,777	22,294	22,814	23,332	23,851	24,369	24,888	25,406	25,925
13/16	7/8	.6013	22,849	23,451	24,052	24,653	25,255	25,856	26,457	27,058	27,660	28,261	28,862	29,464	30,065
7/8	15/16	.6903	26,231	26,922	27,612	28,302	28,993	29,683	30,373	31,063	31,754	32,444	33,134	33,825	34,515
15/16	1	.7854	29,845	30,631	31,416	32,202	32,987	33,772	34,558	35,343	36,128	36,914	37,700	38,485	39,270
1	1 1/16	.8866	33,691	34,577	35,464	36,350	37,237	38,123	39,010	39,897	40,784	41,670	42,556	43,443	44,330
1 1/16	1 1/8	.9940	37,772	38,766	39,760	40,754	41,748	42,742	43,736	44,730	45,724	46,718	47,712	48,706	49,700
1 1/8	1 3/16	1.1075	42,085	43,192	44,300	45,407	46,515	47,622	48,730	49,837	50,945	52,052	53,160	54,267	55,375
1 3/16	1 1/4	1.2272	46,634	47,862	49,088	50,315	51,542	52,770	53,997	55,224	56,451	57,678	58,905	60,133	61,360
1 1/4	1 5/16	1.3530	51,414	52,767	54,120	55,473	56,826	58,179	59,532	60,885	62,238	63,591	64,944	66,297	67,650
1 5/16	1 3/8	1.4849	56,426	57,911	59,396	60,881	62,365	63,851	65,336	66,820	68,305	69,790	71,275	72,760	74,245
1 3/8	1 7/16	1.6230	61,674	63,297	64,920	66,543	68,166	69,789	71,412	73,035	74,658	76,281	77,904	79,527	81,150
1 7/16	1 1/2	1.7671	67,150	68,917	70,684	72,451	74.218	75,985	77,752	79,519	81,287	83,054	84,821	86,588	88,355
1 1/2	1 9/16	1.9175	72,865	74,782	76,700	78,617	80,535	82,452	84,370	86,287	88,205	90,122	92,040	93,957	95,875
1 9/16	1 5/8	2.0739	78,808	80,882	82,956	85,030	87,104	89,178	91,252	93,325	95,399	97,473	99,547	101,621	103,695

TABLE 2—SHEARING VALUE OF RIVETS (DRIVEN SIZE)

Double Shear = 1¾ Times Single Shear

Diameter of Rivet.	Driven Rivet or Rivet Hole		Ultimate Shearing Strength (Lb. per Sq. In.)											
Inches	Diameter, Inches	Area, Sq. In.	38,000	39,000	40,000	41,000	42,000	43,000	44,000	45,000	46,000	47,000	48,000	49,000	50,000
1/2	9/16	.2485	16,525	16,937	17,395	17,829	18,265	18,699	19,134	19,588	20,004	20,438	20,872	21,306	21,744
9/16	5/8	.3068	20,401	20,939	21,476	22,011	22,550	23,086	23,623	24,160	24,698	25,235	25,772	26,308	26,845
5/8	11/16	.3712	24,685	25,335	25,984	26,633	27,282	27,932	28,583	29,232	29,881	30,530	31,180	31,831	32,450
11/16	3/4	.4418	29,379	30,152	30,926	31,752	32,473	33,246	34,018	34,792	35,565	36,339	37,112	37,886	38,657
3/4	13/16	.5185	34,480	35,387	36,295	37,201	38,110	39,014	17,110	40,831	41,739	42,646	43,554	44,460	45,369
13/16	7/8	.6013	39,986	41,039	42,091	43,143	44,196	45,248	46,300	47,351	48,405	49,457	50,508	51,562	52,614
7/8	15/16	.6903	45,904	47,113	48,321	49,528	50,738	51,945	53,153	54,360	55,569	56,777	57,984	59,194	60,401
15/16	1	.7854	52,229	53,604	54,978	56,353	57,727	59,101	60,476	61,850	63,224	64,999	65,975	67,349	68,722
1	1 1/16	.8866	58,959	61,210	62,062	63,612	65,165	66,715	68,267	69,820	71.372	72,922	74,473	76,025	77,577
1 1/16	1 1/8	.9940	66,101	67,840	69,580	71,319	73,059	74,798	76,538	78,277	80,017	81,756	83,496	85,235	86,975
1 1/8	1 3/16	1.1075	73,649	75,586	77,525	79,462	81,401	83,338	85,277	87,215	89,154	91,091	93,030	94,967	96,906
1 3/16	1 1/4	1.2272	81,609	83,758	85,904	88,051	90,198	92,347	94,495	96,642	98,789	100,936	103,084	105,233	107,380
1 1/4	1 5/16	1.3530	89,974	92,342	94,710	97,078	99,445	101,813	104,181	106,549	108,916	111,284	113,652	116,020	118,387
1 5/16	1 3/8	1.4849	98,745	101,344	103,943	106,542	109,139	111,739	114,338	116,935	119,534	122,132	124,731	127,330	129,929
1 3/8	1 7/16	1,6230	107,929	110,770	113,610	116,450	119,290	122,131	124,971	127,811	130,651	133,492	136,332	139,172	142,012
1 7/16	1 1/2	1.7671	117,512	120,605	123,697	126,789	129,881	132,974	136,066	139,158	142,252	145,344	148,437	151,529	154,621
1 1/2	1 9/16	1.9175	127,514	130,868	134,225	137,580	140,936	144,291	147,647	151,002	154,359	157,713	161,070	164,425	167,781
1 9/16	1 5/8	2.0739	137,914	141,543	145,173	148,802	152,432	156,061	159,691	163,319	166,948	170,578	174,207	177,837	181,466

TABLE 3—SAFE LOADS ON STAYBOLTS

Diameter in Inches	Threads				Area		Safe Load at Stress per Sq. In. of										
	No. per inch																
	U. S.	Sharp V	Depth	Diam. at Root	At Body	Root of Thread	4,000 lb.	4,500 lb.	5,000 lb.	5,500 lb.	6,000 lb.	6,500 lb.	7,000 lb.	7,500 lb.	8,000 lb.	8,500 lb.	9,000 lb.
½	13	....	.0500	.4001	0.196	0.126	504	567	630	693	756	819	882	945	1,008	1,071	1,134
	....	10	.0866	.3268	0.196	0.084	336	378	420	462	504	546	588	630	672	714	756
	....	12	.07217	.3557	0.196	0.099	396	445	495	544	594	643	693	742	792	841	891
5/8	11	....	.0590	.5069	0.307	0.202	808	909	1,010	1,111	1,212	1,313	1,414	1,515	1,616	1,717	1,818
	....	10	.0866	.4518	0.307	0.160	640	720	800	880	960	1,040	1,120	1,200	1,280	1,360	1,440
	....	12	.07217	.4807	0.307	0.181	724	814	905	995	1,086	1,176	1,267	1,357	1,448	1,538	1,629
¾	10	....	.0649	.6201	0.442	0.302	1,208	1,359	1,510	1,661	1,812	1,963	2,114	2,265	2,416	2,567	2,718
	....	10	.0866	.5767	0.442	0.261	1,044	1,174	1,305	1,435	1,566	1,696	1,827	1,957	2,088	2,218	2,349
	....	12	.07217	.6057	0.442	0.288	1,152	1,296	1,440	1,584	1,728	1,872	2,016	2,160	2,304	2,448	2,592
⅞	9	....	.0722	.7307	0.601	0.420	1,680	1,890	2,100	2,310	2,520	2,730	2,940	3,150	3,360	3,570	3,780
	....	10	.0866	.7018	0.601	0.387	1,548	1,741	1,935	2,128	2,322	2,515	2,709	2,902	3,096	3,289	3,483
	....	12	.07217	.7307	0.601	0.419	1,676	1,885	2,095	2,304	2,514	2,723	2,933	3,142	3,352	3,561	3,771
1	8	....	.0812	.8376	0.785	0.550	2,200	2,475	2,750	3,025	3,300	3,575	3,850	4,125	4,400	4,675	4,950
	....	10	.0866	.8268	0.785	0.537	2,148	2,416	2,685	2,953	3,222	3,490	3,759	4,027	4,296	4,564	4,833
	....	12	.07217	.8557	0.785	0.575	2,300	2,587	2,875	3,162	3,450	3,737	4,025	4,312	4,600	4,887	5,175
1⅛	7	....	.0928	.9394	0.994	0.694	2,776	3,123	3,470	3,817	4,164	4,511	4,858	5,205	5,552	5,899	6,246
	....	10	.0866	.9518	0.994	0.711	2,844	3,199	3,555	3,910	4,266	4,621	4,977	5,332	5,688	6,043	6,399
	....	12	.07217	.9807	0.994	0.755	3,020	3,397	3,775	4,152	4,530	4,907	5,285	5,662	6,040	6,417	6,795
1¼	7	....	.0928	1.0644	1.227	0.893	3,572	4,018	4,465	4,911	5,358	5,804	6,251	6,697	7,144	7,590	8,037
	....	10	.0866	1.0768	1.227	0.911	3,644	4.099	4,555	5,010	5,466	5,921	6,377	6,832	7,288	7,743	8,199
	....	12	.07217	1.1057	1.227	0.960	3,840	4,320	4,800	5,280	5,760	6,240	6,720	7,200	7,680	8,160	8,640
1⅜	6	....	.1082	1.1585	1.485	1.057	4.228	4,756	5,285	5,813	6,342	6,870	7,399	7,927	8,456	8,984	9,513
	....	10	.0866	1.2018	1.485	1.134	4,536	5,103	5,670	6,237	6,804	7,371	7,938	8,505	9,072	9,639	10,206
	....	12	.07217	1.2307	1.485	1.189	4,756	5,350	5,945	6,539	7,134	7,728	8,323	8,917	9,512	10,106	10,701
1½	6	....	.1082	1.2835	1.767	1.295	5,180	5,827	6,475	7,122	7,770	8,417	9,065	9,712	10,360	11,007	11,655
	....	10	.0866	1.3268	1.767	1.383	5,532	6,223	6,915	7,606	8,298	8,989	9,681	10,372	11,064	11,755	12,447
	....	12	.07217	1.3557	1.767	1.443	5,772	6,493	7,215	7,936	8.658	9,379	10.101	10,822	11,544	12,265	12,987
1⅝	5½	....	.1180	1.3888	2.074	1.515	6,060	6,817	7,575	8,332	9,090	9,847	10,605	11,362	12,120	12,877	13,635
	....	10	.0866	1.4518	2.074	1.655	6,620	7,447	8,275	9,102	9,930	10,757	11,585	12,412	13,240	14,067	14,895
	....	12	.07217	1.4807	2.074	1.722	6,888	7,749	8,610	9,471	10,332	11,193	12,054	12,915	13,776	14,637	15,498
1¾	5	....	.1299	1.4902	2.405	1.746	6,984	7,857	8,730	9,603	10,476	11,349	12,222	13,095	13,968	14,841	15,714
	....	10	.0866	1.5768	2.405	1.953	7,812	8,788	9,765	10,741	11,718	12,694	13,671	14,647	15,624	16,600	17,577
	....	12	.07217	1.6057	2.405	2.025	8,100	9,112	10,125	11,137	12,150	13,162	14,175	15,187	16,200	17,212	18,225
1⅞	5	....	.1299	1.6152	2.761	2.051	8.204	9,229	10,255	11,280	12,306	13,331	14,357	15,382	16,408	17,433	18,459
	....	10	.0866	1.7018	2.761	2.275	9,100	10,237	11,375	12,512	13,650	14,787	15,925	17,062	18,200	19,337	20,475
	....	12	.07217	1.7307	2.761	2.352	9,408	10,584	11.760	12,936	14,112	15,288	16,464	17,640	18,816	19,992	21,168
2	4½	....	.1443	1.7113	3.142	2.302	9,208	10,359	11,510	12,661	13,812	14,963	16,114	17,265	18,416	19,567	20,718
	....	10	.0866	1.8268	3.142	2.621	10.484	11,794	13,105	14,415	15,726	17,036	18,347	19,657	20,968	22,278	23,589
	....	12	.07217	1.8557	3.142	2.704	10,816	12,168	13,520	14,872	16,224	17,576	18,928	20,280	21,632	22,984	24,336

least four modes of failure in order to obtain the lowest efficiency. In figuring the strength of seams, the driven diameter of the rivet is generally used, although the writer has recently come in contact with some information in connection with one of the boiler commissions, which allows only the initial size of the rivet to be used. The allowance generally considered is 1/16 in. larger than the initial size of the rivet, although some practices recently adopted have reduced this to 1/32 in. increase; it would therefore be necessary, in calculating the efficiencies, to use the practice in vogue.

Formulas 1 to 8, cover the different steps for calculating the stresses as outlined. After obtaining the weakest conditions, the efficiency is then found by dividing this value by the value of the solid plate (No. 1). A well designed longitudinal seam should run about 85 per cent to 92 per cent efficiency. The diamond seam, such as is used by the Baldwin Locomotive Works, gives a very large efficiency, running from about 95 per cent to 98 per cent. The circumferential seams are lower in efficiency than the longitudinal, running 60 to 70 per cent.

EFFICIENCY OF THE JOINTS

The meaning of the reference letters in the various formulas is as follows:

A = Area of driven rivet or rivet hole.
C = Crushing strength per square inch.
D = Inside diameter of boiler.
d = Diameter of rivet holes.
e = Efficiency of riveted joint.
f = Factor of safety.
h = Margin (distance between edge of plate and rivet hole).
L = Length of repeating section in inches.
n = Equivalent number of rivets in single shear in a repeating section.
O = Pitch of rivets.
P = Boiler pressure (pounds per square inch).
R = Shearing strength per square inch of plate.
r = Radius of boiler.
S = Shearing strength per square inch of rivet metal.
s = Stress in plate per square inch.
T = Tensile strength of plate per square inch.
t = Thickness of plate in inches.

The ultimate tensile strength of steel plates is based on 55,000 lb. per sq. in. where actual figures are available. Where actual figures are not available, a tensile strength of 50,000 lb. is used. The ultimate tensile strength of wrought iron plates is based on 45,000 lb. per sq. in.

The shearing stress of steel rivets in single shear is taken at 44,000 lb. per sq. in. and 88,000 lb. in double shear. The shearing stress of iron rivets in single shear is taken at 38,000 lb. per sq. in., and 76,000 lb. in double shear. The shearing stress of a plate is considered to be the same as its tensile strength. Rivets in double shear are considered to be equal to two rivets in single shear. In calculating the strength of riveted joints, a length of repeating section is used, which is equal to the pitch of the outer row of rivets. The ultimate crushing value of steel plates and rivets is based on 90,000 lb. per sq. in.

The strength of the solid plate $= L \times t \times T$ 1

The shearing of one rivet $= A \times S$ 2

Stress to tear the plate along the line of rivets $= (O - d)\ t\ T$ 3

Stress to tear the plate between the rivet hole and the edge of the plate (one rivet) $= \frac{4\ T\ t\ h^2}{3\ d}$ 4

Stress to crush the rivet or the plate in front of the rivet (one rivet) $= (t\ d)\ C$ 5

Stress to shear the plate in front of the rivet (one rivet) $= 2\left(\frac{d}{2} + h\right) t\ R$ 6

Shearing stress on rivets for a repeating section (lb. per sq. in.) $= \frac{D\ P\ L}{2\ n\ A}$ 7

Tension on the net section of the plate in the longitudinal seam (to be calculated for the seam of lowest efficiency) $= \frac{D\ P\ L}{2\ (L - d)\ t}$ 8

BURSTING PRESSURE

The pressure required to rupture a cylindrical boiler is

Longitudinal seam, $P = \frac{T\ t}{r}\ e$ 9

Circumferential seam, $P = \frac{2\ T\ t}{r}\ e$ 10

Note.—It will be noted that a circumferential seam is just twice as strong as a longitudinal seam.

While this gives the pressure at which the boiler would fail, a pressure considerably below this must be adopted to insure safety. So far, it seems to be the object of the Interstate Commerce Commission to encourage a factor of safety of four; in fact, this was fixed for all locomotives constructed after January 1, 1912.

The safe working pressure is then found by substituting the required factor of safety in formulas 9 and 10, which then become as shown in formulas 11 and 12, as follows:

Longitudinal seam, $P = \frac{T\ t}{r\ f}\ e$ 11

Circumferential seam, $P = \frac{2\ T\ t}{r\ f}\ e$ 12

The thickness of plate may then be found by the following formula:

$t = \frac{P\ d\ f}{2\ T\ e}$ 13

The stress in the longitudinal and circumferential seams may be found as shown in formulas 14 and 15:

Longitudinal seams, $s = \frac{r\ P}{t}$ 14

Circumferential seams, $s = \frac{r\ P}{2\ t}$ 15

STRESS ON STAYS

When calculating the area of the unsupported portion of the backhead and front tube sheet, to obtain the stress in the stays supporting them, some authorities allow more to be supported by the flange of the sheet than others. By referring to Fig. 1 it will be seen that an allowance of 3 in. is shown. This is the space most generally used, although it has been assumed by some designers to be as high as 6 in. Theoretically, the area to be supported would begin at the point where the curve joins the straight sheet.

The greater the angle of the supporting stays on the backhead and front tube sheet, the greater will be the stress in the stays.

For convenience in calculations the value of $\frac{(1.13)^2}{D}$ in formula 16, is given for stays ranging from 1 in. up to 1⅝ in., as shown in the table.

In calculating the area of the front tube sheet to be supported, there is a diversity of opinion, particularly in regard to the hole in the sheet through which the dry pipe passes. The height of 2 in. above the line of the tubes seems to be generally used for the lower line of the segment to be supported, and 3 in. in from the flange has also been considered good practice.

Some authorities make allowance for the reinforcing ring around the dry pipe in the hole in the front tube sheet. This gives a surface equal to the area of a circle equivalent to the outside diameter of the reinforcing ring for the dry pipe. Others allow only for the hole itself, or half of the hole, or an arbitrary percentage of it. The various locomotive builders differ on this, and each uses a different value. The writer also knows of a case where it was argued that no allowance should be made, the claim being that the hole was unbalanced, due to the fact that the steam pipe was open to the atmosphere. To offset this, it would appear that there should be taken into consideration the

fact that the standpipe is securely anchored in the dome, the heavy reinforcing ring around the hole in the tube sheet, which also comes up close to the flange, the resistance offered by the steam pipes in the smoke box, etc., and that these would about equalize this condition. It is believed that after summing up the different conditions, if the hole in the sheet is disregarded, or the area of the segment minus the area of the hole is used, it will give a result which will be practically realized. In actual practice there seems to be very little trouble experienced with the failure of the diagonal braces on the front tube sheets, and after all this is not the most important part of the design, as the flat sheets themselves, as well as the T-irons and angles, offer some support which is not taken into account in any of the calculations.

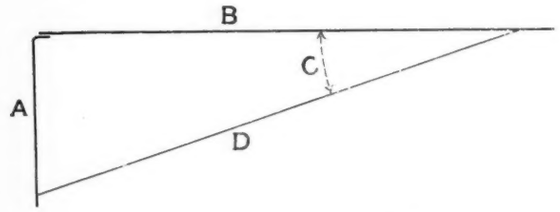
Let T equal the stress in the stay; A, the area supported by the stay; P the boiler pressure, lb. per sq. in.; B the diameter of the stay in inches.

In calculating the stress in the stays supporting the segment on the backhead and the front tube sheet it is considered in the following analysis that each stay supports an equal area. When the area of the segment is determined by a planimeter, taken from a drawing known to be accurate and to scale, the result obtained should be multiplied by the square of the scale of the drawing, e. g.:

If the scale of the drawing is ¾ in. to the foot, or 1/16 size, the actual area of the segment would be equal to the planimeter reading multiplied by 16 squared, or 256.

$$T = \frac{A \times P}{\text{Cos. } C} \times \frac{(1.13)^2}{D} \quad \ldots\ldots 16$$

$$\text{Cosine } C = \frac{B}{D}$$



CONSTANTS FOR VALUE OF $\frac{(1.13)^2}{D}$

1 in. diameter stay	1.28
1⅛ in. diameter stay	1.008
1¼ in. diameter stay	.817
1⅜ in. diameter stay	.676
1½ in. diameter stay	.567
1⅝ in. diameter stay	.482

The area to be braced in the front tube sheet is equal to the area of the segment minus the area of the hole *A* for the steam pipe as shown in Fig. 1. Two inches is allowed above the top row of tubes for the area supported by them.

The same conditions exist on the backhead when calculating the area of the segment, except that the lower line of the segment *XY* is considered to be half way between the top row of firebox stays and the bottom row of diagonal or flue stays.

FORMULA FOR CALCULATING AREA OF SEGMENT

Let A equal the area of a segment; H, the height, and R the radius. Then

$$A = \frac{4\,H^2}{3}\sqrt{\frac{2\,R}{H}} - .608$$

STAYBOLTS

The next subject to take into consideration is the stress on the staybolts. Diagram *A* in Fig. 2 represents the actual conditions that exist in the firebox; that is, the actual area supported by one stay is the square of the pitch (if equal) minus the area of the stay. The general method, however, is to consider the area as represented by *B*, or equivalent to the square of the pitch, disregarding the area of the stay. The 3/16 in. tell-tale hole in the outer end of the staybolt, while actually decreasing the net sectional area of the stay, is generally disregarded.

The Whitworth screw-thread is now being used quite extensively on staybolts. The difference between the Whitworth and the V thread is that the Whitworth thread has a rounded section at the top and at the root of the thread, while the V thread is sharp at the top and the root. The angle of the Whitworth thread is 55 deg., while that of the V is 60 deg. The relative life and strength of staybolts provided with either of the two threads mentioned has been determined through test. In a vibration test each bolt was screwed and riveted in a ½-in. steel plate in the same manner in which staybolts are secured to the boiler. Each bolt was given a vibration of ⅜ in.; the average number of vibrations withstood by the V thread staybolt was 1,485, while the average for the Whitworth thread staybolt was 3,437. In a second series of tests, each bolt was given 10,500 vibrations through an arc of 3/16 in., and then vibrated to destruction through an arc of ⅜ in. In this case the V thread staybolt averaged 791 additional vibrations, while the Whitworth thread failed at 1,932 vibrations. One very noticeable feature of the test was that the Whitworth thread staybolts held to the sheets much tighter than the V thread bolts, and also showed no tendency to cut into the sheet.

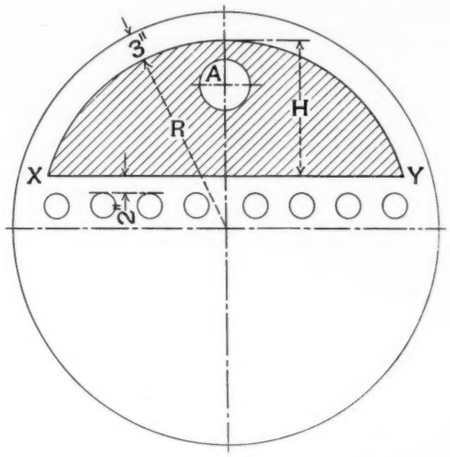


Fig. 1

Bending tests were also made and in these the V thread failed when bent over a 3 in. diameter pin, while the Whitworth thread bolt withstood a bending over a 2 in. diameter pin, but failed when bent over a 1⅞ in. diameter. These tests indicate the theoretical superiority of the Whitworth thread for staybolts, while the practical superiority has been demonstrated by the great decrease in broken staybolts on several roads which have adopted the Whitworth thread as standard.

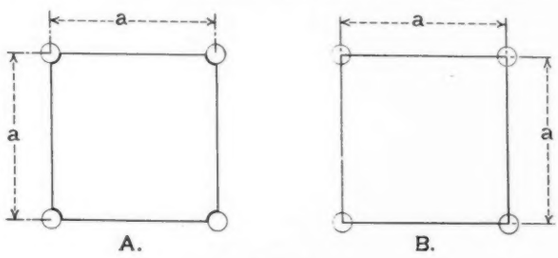


Fig. 2

Table 3 gives the safe loads on staybolts for various stresses and diameters, and covers figures for both the sharp V thread and the United States standard thread, with both 10 and 12 threads per inch.

The formulas for deriving the diameter of the staybolt at the bottom of the thread for the V and the Whitworth threads are as follows:

(V thread) $d = D - (P \times 1.732)$
(Whitworth thread) $d = D - (P \times 1.2807)$

where D = outside diameter of the bolt,
d = diameter at the root of the thread,
P = pitch of the thread.

CROWN STAYS

The next subject is that of crown stays. In calculating the stress on the crown stays, the same general conditions apply as in the case of the ordinary staybolt. It will be noted from

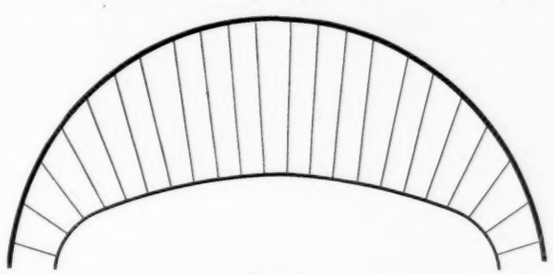


Fig. 3

Fig. 3 that the area of the portion supported on the outer end of the crown stays is greater than the area supported on the lower end, and in calculating the stress, the area at the crown sheet or lower end of the stays should not be considered.

GIRDER STAYS

In calculating the value of girder stays where there is a bearing on the top edge of the side sheets, the girders are considered as a beam, uniformly loaded and supported at both ends. A fiber stress of 17,000 lb. is allowed as the maximum stress in the girders; all above this amount is considered as being transmitted and carried by the slings connected to the roof of the boiler.

The following formulas are used in calculating the stress on girder stays and sling stays:

$$W = L \times O \times P$$

$$W_1 = \frac{f \times 8 \times b \times d^2}{L \times 6}$$

$$S = \frac{W - W_1}{n \times a}$$

where a = area of driven rivet;
b = width of girder stay;
d = depth of girder stay;
f = fiber stress (assumed 17,000 lb.);
L = span of girder;
n = number of rivets per girder stay;
O = pitch of crown bolts;
P = boiler pressure;
S = stress per square inch in rivets;
W = total load supported;
W_1 = weight supported by girder (at fiber stress of 17,000 lb.).

RECORD KEEPING.—One of the important duties of an editor of this paper is to visit power plants for the purpose of obtaining first-hand information on actual operating conditions. These visits reveal, among many other things, a lack of record keeping of plant performances that is astonishing in view of all that has been said and shown to emphasize the importance of the practice. And this paucity of recorded information is not confined to small plants. It exists in plants where the opposite conditions would be expected. Then, too, plants are found where the multiplicity of record and report forms would bewilder a confirmed systematizer. Often this condition is temporary, for it proves difficult in practice to arrive at the most suitable forms without having come to them by the adoption and elimination of numerous others. The condition is then excusable.—*Power.*

TRAINING MEN FOR ENGINE HOUSE WORK

BY CHARLES MAIER

One of the most difficult problems that the roundhouse foreman has to solve is that of maintaining an organization of thoroughly competent and reliable men. While the principal trouble in this direction is in regard to mechanics, it also applies to the rest of the trained labor, such as hostlers, inspectors, etc. It is bad enough with the day force, but it is even worse with the night force. The nature of the work, and the conditions under which it must be done, require much patience and endurance. This drives the best mechanics to the back shops, and the more intelligent laborers into other lines of work. As a result it is often necessary to hire for laborers a class of men who cannot speak the English language, or who speak and understand it so poorly that it is difficult to understand them, or to make them understand what is being said. On account of this it is a difficult matter to judge a man's intelligence or to judge what line of work he is best suited for. Such men often turn out to be the very best kind of men for engine house work, but on the other hand many of them would never rise above laborers.

It is just as necessary for a roundhouse to have an intelligent class of laborers as it is to have good mechanics. Considerable has been said and written about the training of apprentices and excellent results are being obtained, but apprentices do not, as a general rule, come to the roundhouse after they have finished their training. The long hours and difficult working conditions do not appeal to the average apprentice graduate, and he generally selects the back shop for his future. This makes it necessary to train roundhouse mechanics from the force at hand, and if this force is made up of poor material a poor set of mechanics is the result.

Many intelligent young men start work in a roundhouse with the intention of going firing and becoming enginemen. These young men are often used on roundhouse jobs that require special training, and about the time they become useful they are sent out firing. This makes some foremen avoid hiring men who are eligible as firemen, as they prefer men who are apt to stay after they are trained. There should be no trouble in obtaining intelligent, ambitious laborers to work in roundhouses. There is more chance for advancement for them and the work is steadier than in any other branch of railroad work. The fact that the roundhouses cannot attract the better class of laborers shows there is something wrong. Young men who are doing clerical work hesitate before taking a laboring position because they cannot see anything definite in the way of bettering their condition. If such men could be given a definite promise that after they had acquired a certain amount of knowledge and skill they would be given the first opening for promotion they would be apt to stay, feeling that as there was something to work for they could overlook the discouraging features that might otherwise drive them to some other line of work.

All the laborers hired in a roundhouse cannot become mechanics, and some of them never could be made into mechanics, but they probably could be made to fill other responsible positions satisfactorily. With a regular system of examinations conducted annually, or oftener if found desirable, the men could be assigned to work for which they show a special aptitude, and they would then feel that they are going to amount to something. This would also have a tendency to make them pay more attention to their work and to take a greater interest in it. In most roundhouses it is the custom to promote men as vacancies occur, but there is no definite method except that the foreman uses his judgment. In doing this he may promote a man comparatively new in the service because of this man's superior ability, and this causes dissatisfaction among some of the older men who probably feel that they could handle the work as well. These men in turn speak to newly hired men and tell them there is no chance for

them around that place, citing their own case as an example. Another thing in connection with this method of promotion is that the men ask for positions on account of the immediate increase of wages they will receive, without looking ahead to a possible chance of being better off in the end. In this way many a man who might have become a good mechanic goes to the ash pit as a hostler instead. He probably was a helper in the shop and doing his work well and conscientiously when the opening for a hostler's position occurred. Because this position pays more than the one at which he is working, the man is induced to ask for it, and when he obtains it he probably can advance no further.

Now if this man had known that after he passed certain examinations he would be eligible for advancement until he was classed as a mechanic, he probably would have let the position of hostler go and aimed for the higher place. To make this system more effective, all the men working in roundhouses on one division should be classed in a pool. Thus, the man working in the small roundhouse would have an equal opportunity with those in the larger ones. On the other hand, the small roundhouse would be assured of having a capable man if one of the small force employed there were to leave. This would necessitate the keeping of a record of the men in the division master mechanic's office, and it would give him a complete record of his working force and their ability.

In following such a plan there should be eight grades, from the position of laborer to that of a first-class, all-around mechanic. Each grade should have a rate higher than that of the preceding grade by an amount equal to one-eighth of the difference between the pay of a laborer and that of a first-class mechanic. The length of time a man must work in each grade would be determined by the demands of the service, but there should be a minimum time of at least six months, and in some of the higher grades at least one year. A laborer starting in to help mechanics should be put on probation for six months to see if he is adapted to that kind of work. He should in this time get a knowledge of where to go for various tools and supplies and obtain a general idea of what is required of a helper. If he is found to be qualified he should then be advanced to the first grade. Here he would be expected to learn such things as the sizes of nuts and bolts, sizes of pipes, how to cut threads with dies, the difference between rough and fitted bolts and where and why each kind is applied to an engine. He should know about which tools will be required for various jobs and should be able to do ordinary tightening up work. After he has actually done all of this kind of work and can give a satisfactory explanation of it, he would be eligible for the second grade. Here he should learn to grind in and pack globe valves, etc., renew joints in pipes, renew tank hose and brake shoes, take out and repack grease cellars, etc. Each grade would thus cover certain classes of the roundhouse work.

To receive the pay of the eighth grade a man should be so proficient in all-around repair work that he can be relied on to go ahead with any kind of a job given him. In this outline no attempt is made to enumerate each kind of job that a man might be called on to perform. It is not intended that a man in any one grade should be confined to the work outlined for that grade, but before he can be advanced to a higher grade he should have actually handled on his own responsibility all the work covered by the grade he is in. The fact that he has worked with a higher-grade man and helped him do this work should not be considered sufficient reason for advancement. Helping a machinist can be almost anything that the helper makes it. He may only help when a lift or pull is required, or may not make a move except when he is told. A man of this kind should not be compared with one who goes ahead just as though the job depended on him. The candidate for each higher grade should be able to give an intelligent oral explanation of the work, and he should be trained to look for the causes that made the repairs necessary. It should be considered evidence of poor workmanship for a mechanic to make repairs and not search for what made the repairs necessary, where this is possible. For example, it is poor workmanship for a mechanic to repair a leak in an air pipe and leave the pipe brace loose, allowing the pipe to vibrate so that it invites another leak and perhaps causes a broken pipe.

This system of grading and examining men would have a tendency to make them observing. Knowing that they will be examined, but not knowing just what the questions may be, they would form the habit of paying closer attention to their work. The outline of work given applies to machinists, but the same principle can be applied to all roundhouse men. This should result in a better trained and more satisfied body of men than can be obtained under present methods.

BUYING BRUSHES ON SPECIFICATIONS

BY H. M. BAXTER

While the purchase of paint and other brushes on the basis of blue prints or specifications is growing less general, it is still more frequently used than it should be. The term "best quality" of any sort of bristle generally included in the specifications is misleading at best and in these days of constantly advancing prices, it is a condition almost impossible to fulfill. It is further absolutely impossible to define, in words, just what solidity and grade of bristle is desired. A sample is necessary to show that. And when it is required, besides matching the sample in quality, to meet precisely all the measurements given in the specifications, it makes a special brush all through, except for the one company who supplied the standard samples. This is where the great objection lies to printed or blue-printed brush specifications. It tends to destroy competition. The manufacturer furnishing the standard samples possesses an advantage both in having the correct sizes and shapes as well as in knowing just what mixtures and qualities of bristle or soft hair are in the brushes.

The fairest way to purchase brushes as well as the best way for the railroad to receive the maximum competition and value, is to order, from several manufacturers, samples of their standard brushes most nearly in conformity with the specifications or needs, in size, shape, style, and method of construction, as well as color, quality, quantity and length of bristle. Those samples should all be tested in actual work and the results made a matter of record, as so many hours of actual service or square feet covered or gallons applied or whatever other unit may be selected.

Such a method, with its ensuing tests, would undoubtedly credit some features to different firms according as their samples proved out in service. This might not be any undesirable result. Tests could be made occasionally during the regular course of work with no additional cost to the railroad by simply keeping a record of how many units were accomplished by certain brushes. By having tests made by the various departments all over the system, a more or less constant check could be kept by compiling them in tabulated form, and by keeping a record of at least one brush from each shipment. It could thus be ascertained whether or not the manufacturer was keeping up his standard. In cases where, for any reason, an impartial test would seem difficult to procure, it would be advisable to purchase several samples of each brush, erasing all names and marks therefrom and giving each manufacturer an identification number, to be kept as a secret record until the completion of the tests. One such numbered set would go to each shop where painting is done. The reports from the different shops would serve as a most effective check on each side. One unit of service should be used throughout the series of tests and it is probable that the hours of actual service is best adapted to the purpose of comparison.

CAR DEPARTMENT

RECLAIMING JOURNAL BOX PACKING

BY ALDEN B. LAWSON

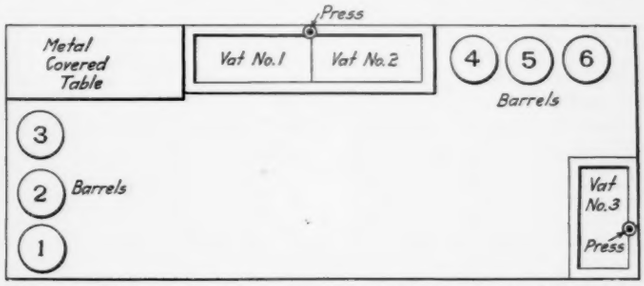
The illustration shows a convenient layout for a plant for reclaiming old journal box packing and a type of cleaning vat which has been fully tried out and gives excellent service.

The vat is made of No. 16 gage galvanized iron and is an inner vat within an outer one, there being a 4 in. space between the two at the bottom, sides and ends. This space is filled with water to the height of the oil and packing in the vat, and steam passing through eleven 1 in. pipes at the bottom, boils the water and heats the oil and waste. At one end of the vat is the cold water and steam inlet as well as the water height gage, while at the opposite end is a steam outlet to the atmosphere and a water drain or outlet.

Equipment Used in Reclaiming Journal Box Packing

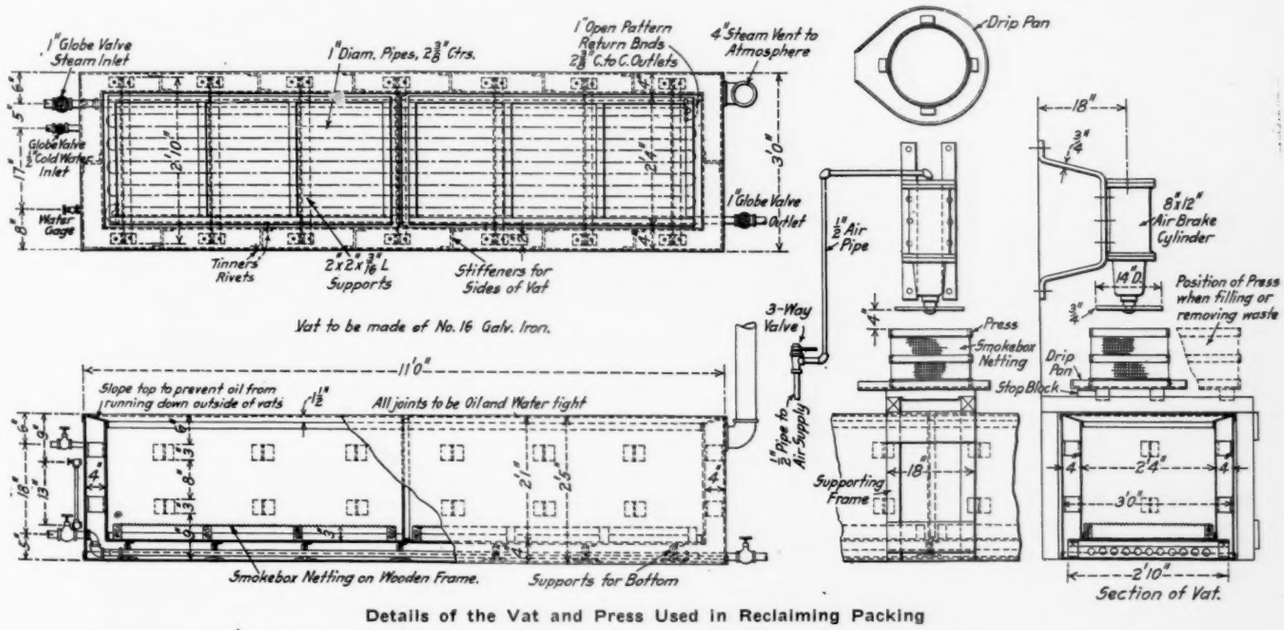
The top edge of the vat is sloped toward the inner vat so that drippings will drain inward. On the bottom of the inner vat is a screen of smoke box netting resting on wooden supports 3 in. high. This permits the dirt and sediment to drain through as it leaves the old waste which is stirred occasionally while under the boiling process. The vat is divided into two compartments by a partition in the center. The waste is first heated in one compartment and the oil pressed out, and it is then heated in the second compartment.

Drawings are also given of the press and drip pan used with the equipment. A bucket made of smoke box netting, substantially braced with wrought iron bands, is employed, and the pressing is done by an air cylinder, arranged vertically with a plunger fitted inside the bucket. A building 10 ft. by 25 or 30 ft. is large enough for this work, unless it is desired to store the material for a time before using. The building should be isolated to avoid danger in case of fire.



Plan of Building Showing a Convenient Arrangement of the Vats, Barrels and Press

The work can be done by two men, one for each vat. A third vat is generally used by the journal box packers for soaking their packing. These vats will handle about ten barrels of waste daily and it will be found advantageous to locate them at the main car repair yards and have shipments made to these main stations from small outlying points in barrel lots, sending one barrel of waste for each one received.



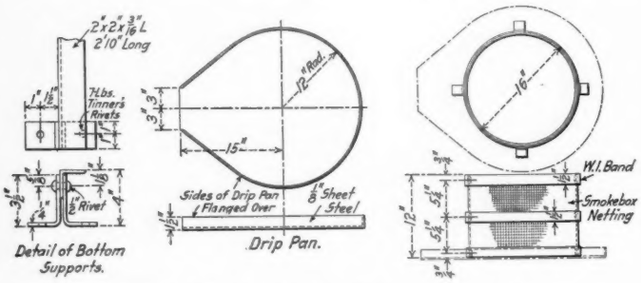
Details of the Vat and Press Used in Reclaiming Packing

A brief description follows of how the work should be done: Old waste to be reclaimed should be spread out, preferably on a metal covered table or platform, where it can be shaken out with pitchforks to remove foreign matter and all short waste

unfit for use. When knots and tangles are found they should be removed by hand, after which the waste is ready to be put in the first vat. In this vat there must be enough oil at a temperature near the boiling point, to cover the waste, which remains in it for not less than half an hour. It is then taken out and placed in the press bucket and the oil pressed out, the oil draining back from the drip pan into the vat from which the waste was taken. The waste is then placed in the second vat and again boiled in oil for half an hour, after which it is taken out, pressed and put in barrels ready for shipment, or taken to the third vat to be soaked in oil for use by the journal box packers. In pressing packing, the oil drainage from the waste should be deflected to the vat from which the waste was taken, as the oil in the second vat will be much cleaner than that in the first one.

Both cleaning vats are in use continuously. In the plan of the building it will be noted that there are six barrels. Those numbered from one to three are used for vat No. 1 and barrels four to six for vat No. 2. When vat No. 1 requires cleaning, which will be when the oil is thick from sediment, the oil should be dipped out and placed in barrel No. 1, where it should remain for 24 hours; then it shoud be dipped out and placed in barrel No. 2 and remain there 24 hours. It is then transferred to No. 3 where it remains until needed for use in vat No. 1. Dipping is resorted to in order to prevent stirring up the sediment at the bottom of the barrels, and neither vat should be continued in service more than 72 hours. The second vat is managed in the same way.

If there is more oil in barrel No. 3 than is needed for vat



Details of the Drip Pan and Press Bucket

No. 1, it may be placed in barrel No. 4 and so transferred up until it passes through barrel No. 6, when it may be used in vat No. 2. It can also be used in vat No. 3 for soaking the packing for journal boxes, but if so it should be filtered. New oil from the oil supply house should never be placed in vat No. 1. If it becomes necessary to use new oil because of an insufficient quantity reclaimed, it should be used in vat No. 3 and in vat No. 2, in the proportion of about 50 per cent of new oil and the same amount of old oil. If barrel No. 3 does not supply a sufficient quantity to care for vat No. 1 and there should be an over supply from barrel No. 6, this should be used in vat No. 1. New oil should never be used in this vat.

Any arrangement may be adopted to suit the operator, but the oil in each vat should be transferred at least three times and allowed to remain at least 24 hours for settling before being used.

The sediment taken from the bottom of the vats and barrels may be used as a lubricant for center plates and side bearings. However, it will be found where there is a large quantity of waste reclaimed that there will be a great accumulation of this sediment, and it is recommended that it be further treated to obtain all the oil possible from it. This may be done by placing a steam heat coil in a barrel in which the sediment is placed, and thoroughly heating it, permitting it to pass through an outlet cock to a funnel screen of fine mesh. By scrubbing the sediment with a bristle brush against the screen, it will be found that a considerable quantity of the oil may be reclaimed and the sediment reduced to a minimum. The oil obtained may be placed in barrel No. 1 and carried through the settling process as described above for use in the vats. If too much sediment is obtained, it should be used as a lubricant where possible, but it will not be a great loss to throw it away.

By the use of this method fully 80 per cent of the old packing is reclaimed, and a considerable quantity of oil is obtained at a very small cost for operation.

FOREIGN CAR QUESTION*

BY D. J. DURRELL

What constitutes revenue freight car equipment? On Classification of Equipment, Form 7, on file in the office of the general agent of the American Railway Association, at Chicago, for the month of June, 1913, is the following data, taken from the replies of 160 roads operating 232,408 miles:

Type of cars	Number in service
Box	1,095,727
Refrigerator	51,974
Stock	81,809
Tank	12,365
Flat	139,866
Dump	35,126
Steel hopper	205,661
Wood hopper	128,270
Coke	38,054
Steel gondola	155,843
Wood gondola	292,252
Other revenue	29,708
Total	2,266,655
Caboose, work, etc.	129,342
Grand total	2,395,997

On October 1, 1913, the actual number of revenue freight cars owned by railroads was 2,360,574. This is for all the railroads in the United States and Canada. These cars were located as follows:

Home cars on home roads	1,292,158
Home cars on foreign roads	1,068,596
Home cars in home shops	144,568
Foreign cars in home shops	32,546

For the year ending October 1, 1913, there had been—putting it in this way, "One car, so many days out of service on account of bad order"—53,309,507 car days, or an average number of days that each car was out of service during the year, of 22.53.

Dividing the United States and Canada into 11 districts and taking the number of cars owned by the lines in each district, we find that of all the cars, the location in per cent of the total cars is:

	Min.	Max.	Avg.
Home cars on home roads	36.37	67.63	54.73
Total cars on lines	89.31	143.35	102.91
Home cars in home shops	2.69	8.01	6.12
Foreign cars in home shops	.33	3.02	1.38
Total in shops	4.87	11.03	7.50

By these figures you will note that the average number of cars owned, that is, home cars at home on their own road, was but 54 per cent of the cars owned. Also that the total cars used compared with those owned varied from 89 to 143 per cent, an average of 102 per cent; in other words, some roads used 43 per cent more cars than they owned. These figures seem large, but they have been verified by reports from the American Railway Association and I feel that they can be depended on. This means a great deal to the railway companies. Take the 32,546 foreign cars in home shops. At a per diem charge of 45 cents, this amounts to $14,645.70 a day; or for a 365 day year, $5,345,680 for per diem charges. Someone may say that the five million dollars thus represented does not leave the coffers of the railways; that it merely passes from one to another and back again. That is very true, but at the same time the cars have been out of service and considering that it is only one day that is taken as a basis, which everyone understands is far below the actual time that foreign cars are held on the repair tracks, we have run up a total yearly per diem charge of over five million dollars and additional days but add to this figure.

*From a paper presented before the Cincinnati Railway Club.

STEEL FREIGHT CAR REPAIR SHOPS

First Prize Article in the Car Department Competition Which Was Closed on February First

BY E. T. SPIDY
Assistant General Foreman, Canadian Pacific, Winnipeg, Man.

In consideration of the fact that each railroad has a different number of steel freight cars to be handled each month, relative to the size of the road, I intend to deal with the subject in the manner of a new problem, putting down as clearly as possible every consideration to be made with a view of maximum output in conjunction with low shop cost. This will enable anyone studying the subject to apply the conclusions to his shop and his conditions, and thereby obtain the best solution for his individual needs. Incidentally I am recording to a degree the actual development of this work on the Canadian Pacific at Winnipeg. We have learned that the only way to really get to the bottom of any problem is to analyze it and then to reconstruct along the lines of good judgment and practical knowledge. Therefore, knowing what our problem is, viz., repairing steel freight cars, I will proceed to tabulate all considerations that must be taken into account and afterwards study each in detail.

Location of Building.—Type of shop required; its relation to other shops and general stores; its relation to the yard; its relation to the special supply storage for structural steel, wood, couplers, etc.; facilities for delivery of material; provision for future extension; provision for further developments in cars.

Structure of Building.—Size of building and general construction; large span of roof compared with short spans; light, heat and sanitary considerations.

Layout of Shop.—Departmental operations: structural steel, blacksmiths, machine work, brake beam work, trucks, woodwork, paint department, etc., office, petty stores and tool room, lavatories and industrial tracks.

Shop Equipment.—Importance of good equipment; machinery required for various operations; special machinery; pipe and power lines.

Operation of Shop.—Shop organization; methods of repair; inspection, classification of repairs, reports, etc.

Location of Building.—There are two types of shop that need especial consideration, viz., longitudinal and transverse. In the first we have a series of long tracks, each of which will accommodate six or more cars, and in the other all tracks are independent and parallel leading out to a transfer table. While the latter is more universal in passenger car shops, it is not an efficient means of transfer for freight cars, because the movement is quicker; that is, they are in the shop a much shorter period and a transfer table is too slow when any number of cars are to be handled. The longitudinal shop, on the other hand, allows a whole track to be drawn at one time. It is not very difficult to classify repairs so that cars which will be in the shop a longer time than others shall be in one section. At the Winnipeg shop, the arrangement is longitudinal and cars are drawn in strings of six or eight. The other end of the shop is served by the transfer table of the general car shop. This allows great flexibility for handling an individual car to be run into the car straightening frame and out again without disturbing the rest of the shop. This end of the shop, however, is not used to a great extent except for the introduction of supplies.

The location of the shop must be such that getting supplies from the general stores is convenient and it must be close to the structural steel rack. There must be sufficient space at the sides of the building to keep a stock of standard repair parts with room for industrial tracks. The importance of having the best possible facilities for the delivery of material cannot be over emphasized because, when the material element is defective, the human element most certainly will lag behind in greater proportion.

It is also necessary to bear in mind that the steel car industry is in its infancy and at some future date extension will be necessary, so at the end away from the supply source the space should not be incumbered with buildings of any description. Also considering that in the future materials of a heavier nature might be used, good judgment is necessary that present space may prove not inadequate for heavier machinery which may be demanded at some later date.

Structure of the Building.—While the material used in the construction of the building does not usually concern the shop engineer or superintendent, the general construction does in many respects. The capacity of the shop is of great importance to him and he must figure out how large a shop is required. We will suppose the present demand is for 60 cars to be repaired each month; then the average time a car will be kept in the shop must be decided. If it is 10 days, this gives us 600 car days a month. There are 25 working days a month and the number of cars in the shop at one time will be 24, or three tracks containing eight cars each. Allowing then for future extension, say 100 per cent, multiplied as per individual requirements, we have the size of shop to be built. It is not advisable to bring the tracks closer together than 22 ft. because room must be provided for industrial tracks for material delivery. A point to note also is that the construction of the shop roof is such that it will not interfere with the industrial track delivery. For instance, in a shop with six tracks the roof would either be made with one or two rows of posts in the shop. It will be seen that it is not practicable to run industrial tracks through the shop where the posts are, and as only one industrial track is required to reach two car tracks, with one row of posts four industrial tracks are required, whereas with two rows of posts only three industrial tracks are needed. In addition it must be remembered that the posts when placed between each two tracks are exceedingly convenient for leading down the pipe lines and also are handy to attach vises. Thus the posts of the shops, when arranged between each two tracks, are more convenient in every respect than larger spans.

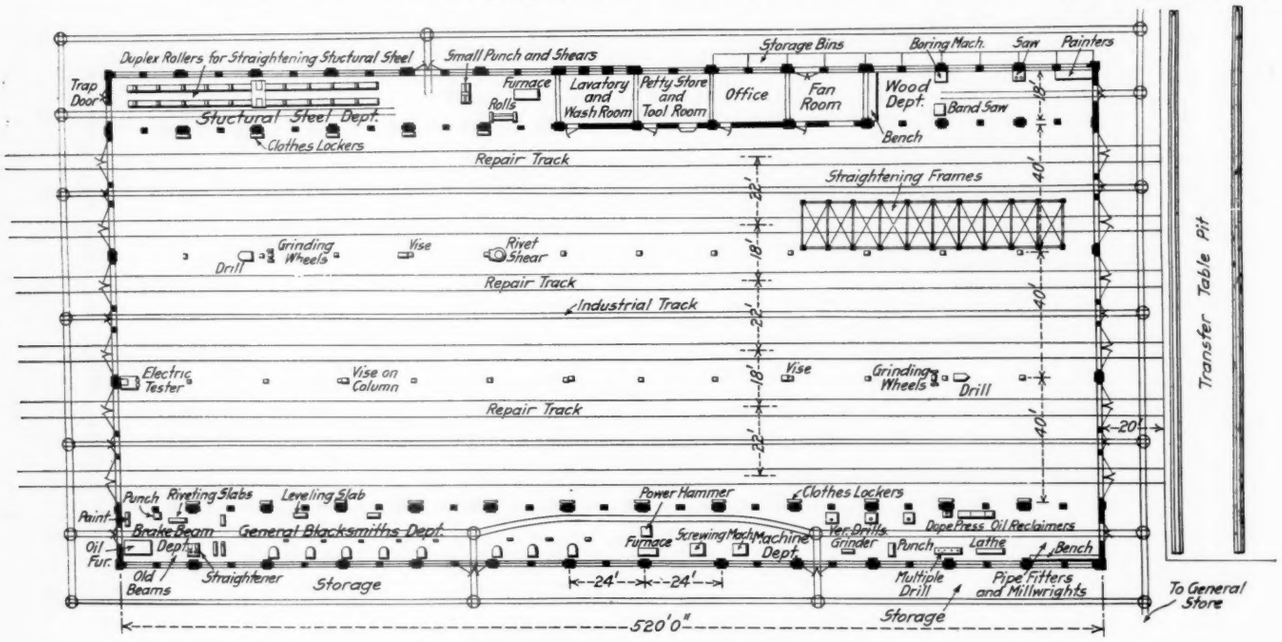
The floor of the shop is of great importance, and in view of the many heating operations necessary on steel cars, it should be constructed of asphalt or other plastic surface about 2 in. thick, bedded on a layer of about 9 in. of concrete. This fireproof floor will well pay its extra expense in the small upkeep cost for repairs, and at the same time it is not at all hard on the workmen's feet.

The roof should be a structural steel type with as little wood as possible. So many crude oil burners which are used in every conceivable place make this precaution highly advisable. Another point worth more than ordinary consideration is daylight. The more daylight available, the better the work; artificial light is a poor substitute underneath a car, and all known methods of securing greatest length of daylight during working hours should be provided.

It is necessary to make provision for all operations to be performed in connection with the repairs undertaken and to provide machinery space. Briefly summarizing, there is drilling, threading of bolts and rods, blacksmithing, repairing brake beams and equipment, straightening structural steel, wood machine work, offices, etc., all of which require space; in addition they must be

easy of access to the shop. All new devices such as safety appliances are manufactured in the manufacturing departments on a larger scale, and stored ready for application. The best place for these small departments is obviously at the sides of the main shop in the form of a low extension. There should be one extension of this kind on each side of the shop and it should extend the whole length of the shop, and be not less than 18 ft. wide to allow of a central industrial track with space for the machinery on each side. The roof of the lean-to should be high enough to provide efficient ventilation. A general fault with most extensions is that they have been added some time after the main building was erected with the result that the daylight has been practically excluded from entering by the side of the shop. Steel car work demands good floor light, and so the pilasters and walls supporting the main shop should be as narrow as possible.

Layout of Shop.—It is necessary to make a complete list of all machinery that is required, including also that which will be required at a later date. The general machinery department and the blacksmith department work hand in hand and should be placed on one side of the shop. The brake beam department, where steel beams are straightened, forms a little group by itself



Plan of Proposed Steel Freight Car Repair Shop

and should be placed close to the blacksmith section. A very good location is directly in the end of the side extension. Brake beams are somewhat clumsy to handle and this position allows of minimum distance to travel, because they can be stocked outside the shop before being repaired and then brought in and removed when repaired without having to travel all the way down the shop.

The blacksmith work requires eight fires for a shop of this size. Blast must be provided at six or eight ounces pressure for the fires, and this should be carried underground in a tile pipe. The fan itself, which is a 24 in. diameter wheel, steel pressure type, can be placed on the wall, the air being sent directly downward into the floor pipes. Smoke hoods must also be provided for the fires, and the pipes on the hoods extended at least 10 ft. through the roof. In cold winter climates a better arrangement is to connect all the hoods to an exhaust fan giving about two ounces suction draft. This pulls the smoke from the fires and does not allow any cold drafts to enter the shop. The fires are backed against the outer wall and the other side of the track is used to deposit material. At the end of the row of fires should be placed an oil furnace for welding brake rods; a small power hammer is also required for this purpose. This will prevent work being taken to the larger blacksmith department and saves much time. The remaining part of this part of the extension can be confined to machine work of a general character.

The extension on the other side of the shop should contain the following units: The heating equipment and the lavatory are important and practically fix themselves as to location at the center of the shop. This then is also, by the same reason of accessibility, the best place for the petty stores and foreman's office. We now have two sections, one at each end of this occupied block, which are needed for the two remaining departments not yet provided for, namely, the structural steel department, where the straightening, punching and cutting can be done, and the wood and paint department which are comparatively small. Truck work is done on the track directly behind the cars from which they are removed and so does not require special space.

Industrial track service of an efficient nature is most necessary. We see from the general layout that in the arrangement shown the tracks run clear through the shop to turntables or smooth plates and around the shop making no undesirable twists and yet every car in the shop can be reached with ease. The end tracks may be made to cross inside the shop in very cold climates, but this is at a sacrifice of car repairing space. Outside tracks should connect with the main shop system of tracks wherever possible. Movable turntables are somewhat expensive items when any number are required, and a far cheaper method is to use a smooth plate. It is the general rule to find turntables stuck and most often no effort is ever made to loosen them up. We have found the smooth plates far more satisfactory in service and use them in all cases, except where very heavy loads are handled.

Shop Equipment.—We will proceed to detail the various operations by first making a list of machinery, as complete as possible. The machinery on this list may not be required at once, but may be looked on as the ultimate complete equipment required when the shop is running full capacity. The advantage of this lies in that it allows a definite location to be settled for what machinery is obtained, so that moving of machines is obviated when work increases so much that the additional equipment is required.

Tools and Equipment:

Brake beam repairing outfit—

1 Oil furnace, inside dimensions 10 ft. by 4 ft.
1 Brake beam straightening machine.
1 Straightening face plate.
1 Water plunge bath.

1 Pneumatic punch or single spindle drill.
4 Riveting tables or slabs.

General blacksmith—

8 forge fires complete with hoods, etc., water boxes, coal and coke bins, anvils, leveling slabs, etc.
1 Oil furnace, welding type, 6 ft. long, 2 ft. deep.
1 Power hammer (electric, belt or air driven), 250 lb. capacity.

General machinery department—

2 Triple head bolt threading machines, capacity up to 2 in. diam.
5 Single spindle drilling machines, capacity up to 2½ in. holes.
1 Multiple spindle drilling machine.
1 Lathe, 16 in. by 10 ft.
1 Pneumatic punch, capacity ⅞ in. hole, ½ in. plate.
1 Dope press.
1 Oil reclaiming outfit.
3 Double floor grinders.
1 Portable shear.

Structural steel and plate outfit—

1 Double straightening roll for straightening bent rolled sections.
2 Steel car straightening frames.
1 Small hand roll.
1 Punch and shear.
1 Furnace 8 ft. long by 3 ft. wide.

Wood machines—

1 Wood boring machine.
1 Rip saw.
1 Band saw.

General equipment—

Vises, hydraulic jacks, trestles, chains, benches, rivet fires, pneumatic hammer, drills and rivet busters, torches, shop trucks, hoisting blocks, etc.

The importance of good and complete equipment is very well recognized. Without losing any meaning in reference to first class equipment, it may be considered that for the class of the work in hand some machines (such as drills for general use in the main shop) do not require to be recent models and equipment replaced in some other shop can be advantageously employed.

It is seen at once that power lines are required in the shop, electric power for the machines and for light. Individual drive is necessary on account of the scattered nature of the arrangement; this is generally most economical, but each case must be treated individually.

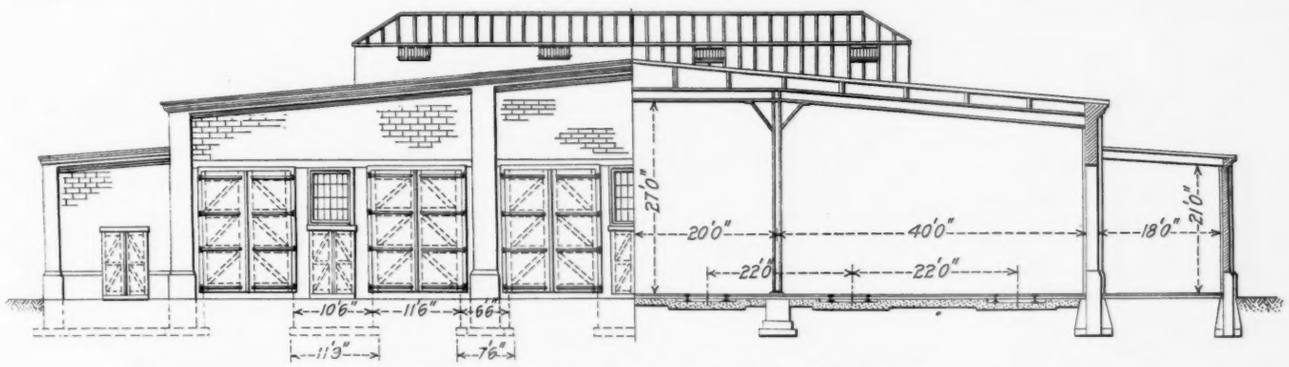
Compressed air is required all over the shop. Every alternate column in the shop and each corresponding wall pilaster should have a drop line with a combination connection to carry three hose lines. While the drops need only be ¾ in. pipe, particular care must be taken that the mains are large enough so that the supply is not throttled on the end of the shop farthest from the main lead pipe.

Fuel oil is required for furnaces and portable rivet fires. This must be piped to the machines direct from a supply tank by gravity flow or by a pump. Pipe lines should be run through the shop by way of the steel columns only, with drops at alternate posts; the post with oil connections should be the same as those connected with compressed air, because all portable fires require air and oil both.

Water requires to be piped to blacksmiths and others using it regularly. These connections should be placed on the shop walls, two connections to each wall, for general requirements. Drinking water should be supplied at stationary fountains so that the use of cups is obviated. Fire hydrants should be placed conspicuously with hose reels ready for any emergency.

Oxygen and acetylene gas connections taken from main shop lines for oxy-acetylene welding and cutting should be made in this shop and pipe lines along the two center columns of the shop with drops for each gas made at alternate columns, these columns being those other than columns with air, oil and water connections. To ensure fool-proofness the oxygen and acetylene lines should end in every case with special keyless valves.

Considering now the different operations in the order named and the layout that will give the best results, the brake beam repairing outfit will do all repairs to steel beams. It will straighten bent beams, apply new beams, replace broken shoes, and attach all links and other gear required to the beam itself. Defective beams are removed from the cars in the shop and placed on a pile outside at a convenient point. New beams or repaired beams are delivered to another pile outside the shop. The layout shown in the plan has been developed in our shop and works very satisfactorily. The old beams are brought into the shop in batches and delivered in a pile by the side of the straightening furnace. Here they are stripped of broken shoes, or the detachable links are removed and the whole is placed in the furnace which will accommodate four or five beams at one time. As one beam is removed it is replaced by another, making the heating operation practically continuous. The beam after being removed from the furnace is then placed in the straightener, which is a machine of local design and consists of two sets of 12 in. x 16 in. cylinders mounted, one pair on a horizontal plane and the other pair on a vertical plane. The cylinders are connected in pairs so that one valve operates the two horizontal cylinders and one valve the vertical ones. The outer ends of the pistons are connected by a suitably shaped heavy cast iron die which presses the hot bent or twisted beam back to its normal shape. The top die is shaped with a high reinforced arch in the center, so that the coupling which is sometimes riveted to the bar is not interfered with as the top die descends. The ends of these dies are just short of the shoes on the beam ends so that the shoes remain undamaged during the operation. The machine is air operated and mounted on a stout structural steel frame. A little manipulation of these cylinders soon enables an experienced operator to remove almost any sort of a kink. Occasionally a beam is bent so that it cannot be inserted in the machine at all; it is then first placed on the leveling plate and roughly straightened with a few hammer blows. After leaving the straightener the beam is placed on the leveling plate, and if the least set is required to bring the shoes in line, this is done with a hammer; the beam is then placed in a cooling bath of water and quenched. This cooling gives a mild temper to the beam and the tests we have made show that a slight increase in rigidity over a new beam results. Fulcrum brackets, etc., are now riveted in place. After dipping in a paint bath the beam is ready for removal from the shop. No mention has been made of the punch used in this con-



Section Through Proposed Steel Freight Car Repair Shop

nection, but quite frequently beams have to be handled that have no safety clips or for some other reason holes are required in the web of the beam. This punch performs all these operations, and will also do the riveting when the dies are changed. A drilling machine is sometimes used for this work, but we find a considerable saving by using the punch. It will be noticed that the beams follow a regular cycle and end at a point where the laborers, who have just dumped a load of old beams, can pick up a load of new beams and remove them from the shop.

It is advisable to place the blacksmith forges as close to the brake beam repairing outfit as possible in order that the blast pressure may not be lowered by long travel through the pipes. Blacksmith forges have been placed at a distance of 12 ft. apart along the outer wall, the backs of the forges being placed so that the light from the windows is not interfered with any more than can be avoided. The space opposite the fires is left for material storage, and part of this blank space could be used when space is required for any special purpose which may develop. At the end of the row of forges is placed an oil furnace for welding truss rods, brake rods, etc., and opposite the furnace is placed a power hammer. This method of placing the hammer directly in front of the furnace is better than the older method of placing the hammer at the side for the reason that both men stand in front of the furnace and each takes one end to be welded from the furnace and both make a single half-turn, after which they are both in position for welding at the hammer. By reason of the success of this method we have changed the position of all similarly operated machines around the different shops. As it is very possible that this work may grow in such proportion as to demand a double unit, space has been left to accommodate it. In order that this outfit may not be hampered by movement of shop trucks, the industrial track has been shifted along this section of the shop close to the main shop wall.

Next to the welding furnace is placed the threading machines, which have a capacity for all sizes up to 2½ in. diameter. These machines will take care of all work handled in the shop and also all rods handled by the blacksmiths. The first machine will handle all the shorter bolts while the second will thread all long rods, space being left to accommodate long rods, like truss rods.

Drilling machines are placed next; these are single spindle machines with tables 30 in. in diameter. These machines need plenty of light and are placed in front of the windows. A multiple spindle drill is very handy, but not an absolute necessity at the beginning.

For general use, the pneumatic punch or riveter is very useful. The double floor grinders for tool and general grinding, and a lathe practically completes the equipment of the machine department on this side. In the corner are benches for use of pipefitters, millwrights and other departments not requiring special machinery. The dope press is, as its name implies, simply an air operated cylinder, the outside piston of which presses down into a chamber filled with old and useless dope. While the dope cannot be used again the oil, after straining, is quite good. The oil is squeezed through small holes in the bottom plate and runs to a pan.

Another special unit is the oil reclaiming plant, which is also of local design. This outfit consists of two tanks in which are steam heating coils. Dope is placed in one tank just as it is removed from the cars, and subjected to heat, which, with the aid of a pump, draws off most of the oil. The comparatively dry dope can then be cleaned more readily. After cleaning it is oiled and placed in the second tank ready for use again. This outfit has been the means of greatly reducing the oil expense.

Passing to the main shop, the machinery is seen to be somewhat scarce, as it should be, all available space being required for car repairs. The only available space is between the shop columns. At two points in the shop is a single drill and a double floor grinder—the drill is to take care of all odd jobs which occur regularly in the day's run, so that delay is avoided in traveling to the machine department, and the grinding wheels are graded for rough grinding of all kinds. These two machines can be driven by a single motor on the shop column with a single countershaft. Another small machine is a short rivet shear. It happens often that special lengths of rivets are required and these have to be cut from larger rivets. This seemingly small item caused much lost time and a small shear was designed especially for this purpose.

Vises attached to every third column are a good substitute for the usual clumsy bench and are out of the way when so attached.

As a means of making the shop as independent as possible an electric tractor, placed at one end of shop, enables cars to be pulled in and out of the shop. By a system of snatch blocks any track can be drawn and filled again with very little trouble.

The steel car straightening frame erected in the Winnipeg shop is similar in pattern to the type erected at different points on the Canadian Pacific and consists of a heavy structural steel housing into which steel cars, having received a side swipe or other wreck damage to the body or underframing, can be placed and jacked back into correct alinement. Each column of this housing is made up of two 12 in. channels reinforced by two 6 in. I-beams, and long screw jacks slide between the channels to the point of application of pressure; between these columns horizontal beams are adjusted so that pressure may be applied from any point on both sides of the car in a horizontal plane. Portable oil burners are used to heat any part of the car in particular and then the pressure from the jack straightens the frame to its original form. Large rings are set in the concrete base and thus by aid of chains and jacks, upward or downward pressure is applied. For a shop of the size shown in the general plan, this straightener should accommodate at least two cars at one time.

On the other side of the shop a new department in car shops is observed. This department resembles a miniature boiler shop and it has all the appliances required to handle structural steel. The large machine is a structural steel straightening roll. The necessity of this machine has become more apparent of late, and we are at present engaged in completing its design. As in the case of brake beams, it will be found to be more economical to remove bent members from a car and to replace them from a stock of straightened members. These bent members can then be placed in a pile and brought into the shop and straightened and returned. If climatic conditions will allow, this machine should be placed outside. The machine has two sets of rolls; one set will accommodate all sizes of Z bars and angles while the other is designed entirely for channels of different sizes. The machine will be high powered with instantaneous reverse mechanism. Extending both front and back of the machine will be long tables with rollers inset so that as the straightening proceeds the bars will run on the guides. Trap doors will be required in the end of the shop so that the straightened long beams can be run right out of the shop without further handling.

Additional equipment in this department will consist of a power punch and shear large enough to cut and punch all structural shapes and also the steel siding. A small hand roll for steel sheeting and a small furnace for heating roof members and other shorter members is required, and possibly also a clamp.

At the other end there is the section devoted to wood workers. This space, while large enough for all wood workers required for car siding and flooring, will ultimately, it may be expected, be superseded by the workers on steel car sides. However, as most of the wood is received prepared from the mill the machinery layed out, viz., two saws and one boring machine, will take care of all required machine work

until that time. Painters and air brake men can also be located in this section. Depending entirely on the location of the steel car shop the steel cars might be removed from the shop as soon as the steel work is completed, and then transferred to the freight shop, where all wood could be applied. This would be a better arrangement in a case where the steel car shop adjoins or almost adjoins the wood freight shop. In such cases the space allotted to wood workers could be occupied by steel plate machine workers.

Operation of the Shop.—The organization of a steel car shop must be made to conform to the local conditions. Local conditions affecting the shop organization are those concerning the class of labor employed and the degree of intelligence obtainable in the men. The duties of all men must be clearly defined and duties must be such as to be easily understood. Steel car repairers are, in some shops, mostly foreigners. It is obvious that we shall meet with little success if we display written instructions regarding repairs to these men if they cannot read them, and yet it is obvious we must instruct them in some way. As illustrative of a typical organization, with possibly the most variable of conditions to be met in workmen, the local conditions at Winnipeg might be cited. Our car repairers are mostly foreigners and are a sort of graduated laborers. These men are of average intelligence and require very little instruction once they get acquainted with the work, but the demand for unskilled labor has been such that no sooner does a man get useful at his work and learns to speak a little English, than he quits and finds something more remunerative. The laborers are changing all the time and efforts to train laborers to obtain material fail, because they do not stay long enough to learn. The high rates of pay for outside unskilled work in this district is responsible to a large extent for this condition.

The whole shop is directed by the shop foreman and he has assistants in the shop. The number of assistants depends on the number of cars per month, but for a shop with six cars to a track, one assistant can handle two tracks. A report of the repairs always reaches the shop in advance of the car and this should give sufficient information to enable the foreman to line up all special material. As soon as the cars are placed in the shop, the assistant foreman carefully inspects each car and marks on the board provided for each car what material is required to be brought in the shop. Certain men in gangs of one car repairer and one laborer are assigned to the cars for the repair work and instructions are given by the assistant foreman. Small tools and appliances are procured by the car repairer from the storeroom, while bolts and other small material are obtained from the stores by the laborer on the foreman's written order. Larger material, that is stocked outside the shop, is brought to the car on the foreman's order by the shop material gang. This gang is composed of laborers headed by a charge hand who speaks English as well as other languages. This man reports to the shop foreman, but takes instructions from all the assistant foremen and delivers material as required. This man is also responsible for the cleanliness of the shop. Thus it is seen that a car repairer has no business whatsoever outside the shop, unless under orders from his foreman.

Painters come directly under the shop foreman and are directed as required around the shop. The "Paint Gun," as it is termed, is a source of economy if used discreetly. On steel car work it is found to be a saving on intricate parts such as trucks, corners of steel structural work, etc., but for flat surfaces the brush painter is better.

All other help in the shop is also controlled by the shop foreman. An assistant foreman desiring preference on certain work must consult the general shop foreman. The organization must always be that each man is responsible to one immediate superior.

The space around the shop outside should be divided up to accommodate a stock of all standard parts and the assistant foreman and gang charge hand should immediately notify the shop foreman when the minimum stock is being reached in any particular. The shop foreman will then order a new stock, so that delay shall not occur from this source. Material delays are the general source of trouble, so that special care must always be taken, particularly in the case of foreign material, that orders are placed as far in advance as possible.

REFRIGERATOR CAR DESIGN

There are differences of opinion regarding the most desirable weights of cars, kinds of insulation, types of icing arrangements, etc., but all experts are agreed that refrigerator cars must be very carefully designed, very well built and very carefully maintained. A refrigerator car is a cold storage plant on wheels, but its service is such that what might be entirely practical for an ordinary cold storage plant may not be practical in a refrigerator car. Likewise the general type of box car construction cannot be followed in all its details in the construction of the refrigerator car. A refrigerator car is heavier than a box car of the same general proportions and capacity because of the added weight of the insulation; and this should be considered in designing the trucks to be used under refrigerator cars. A refrigerator car built to the general design of a box car of a given capacity may never be loaded to the limit of this capacity with perishable freight, the extra weight of the insulation and ice being considered. But trouble comes when such a car is used in other than refrigerator service; for then it is very apt to be overloaded. For this reason some roads have rated their refrigerator cars below the rated capacity of the trucks.

The extra weight of the refrigerator cars is wholly carried in the superstructure, which, together with the high or suspended loads usually carried, will raise the center of gravity of the car an appreciable amount. This has at one time or another caused a large number of derailments, but has been overcome almost entirely by decreasing the distance between the side bearings, having them come well inside of the rails. The standard practice in this regard seems to be 48 in., or 2 ft. each side of the center of the truck, with a clearance of ¼ in. to ⅜ in. Some car designers are strongly in favor of roller side bearings or some anti-friction arrangement that will assist the trucks in traversing curves, as the refrigerator car bodies are of such rigid construction that they will not ease off from the side of the truck as it strikes the elevated outer rail of a curve.

A difficulty that has been experienced by many roads is that of keeping refrigerator cars clean and free from permeating odors. One car company has had very good success in this regard by applying two coats of hot linseed oil to the inside sheathing of the car and covering this with a good grade of varnish. The oil will be absorbed as soon as applied, closing the pores of the wood, and thereby preventing any material amount of absorption of any odors. In addition to this the cars are kept clean with ordinary soap and water.

One of the secrets of success in refrigerator car construction is the building of a car that will withstand all the shocks and torsional strains that may be given to a car in service, without opening cracks in the superstructure that will in any way interfere with the insulating properties of the car. To attain this requires the best possible workmanship, together with a high grade of material. At the same time if the cars are not properly maintained their efficiency will be greatly reduced and the beneficial effects of up-to-date and scientific construction destroyed. Refrigerator cars are built with the definite purpose of protecting in transportation perishable products, the damage claims on account of which, if they are not properly protected, may cost the carrier more than is received in revenue. Therefore, cheapness of construction in such cars may be, and usually is, a most extravagant economy.—*Railway Age Gazette.*

BRAKE PERFORMANCE ON PASSENGER TRAINS

Discussion of Tests Which Were Made on the Pennsylvania Railroad and Discussed by the A. S. M. E.*

BY S. W. DUDLEY
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Realizing the significance of the knowledge and experience accumulated in recent years, the Pennsylvania Railroad, in conjunction with the Westinghouse Air Brake Company, instituted, in the spring of 1913, the most scientific and comprehensive investigation of the different factors affecting the operation of brakes on steam railroad passenger trains that has been undertaken since the Galton-Westinghouse trials of 1878 and 1879. In addition to an examination of the characteristics of brake shoe friction throughout a wide range of laboratory and operating conditions, the test included also a study of the effect of various types of air brake mechanisms and foundation brake rigging and different degrees of emergency braking force.

The tests indicated the degree to which existing apparatus was suited to existing conditions, the direction in which improvement was necessary and could be made, and the amount of improvement actually accomplished.

The limitations of the old brake apparatus are most marked in the following particulars: In the length of emergency stops; the uniformity of brake applications on different vehicles comprising the train; the safety and protective features demanded by service conditions of great severity and complexity; the flexibility and certainty in applying and releasing the brake during service application; and the increased difficulty of keeping the service and emergency functions separate, i. e., insuring quick action when required on the one hand, and preventing it, when not required on the other.

In considering the improvements desirable in the above particulars four factors require special attention:

A The characteristics of the mechanism available for controlling the pressure of the compressed air in the brake cylinders.

B The efficiency of the mechanical transmission of the force of compressed air developed in the brake cylinders, through the rods and levers of the brake rigging to the brake shoes.

C The efficiency of the brake shoe in transforming the pressure imposed on it into retarding force at the rim of the wheel.

D The available adhesion between the car wheels and the rails.

There are four factors which have a controlling influence on the length of stop: (1) the maximum brake cylinder force; (2) the time in which this is obtained; (3) the efficiency of the foundation brake rigging in multiplying and transmitting this force to the brake shoe; (4) the mean coefficient of brake shoe friction.

All but the last factor can be controlled or properly provided for in advance by correct design and installation. On the other hand the experience of recent years has repeatedly demonstrated that no one of these four factors can be neglected without a corresponding loss in effective retarding force. It is therefore of the greatest importance to distinguish and give due consid-

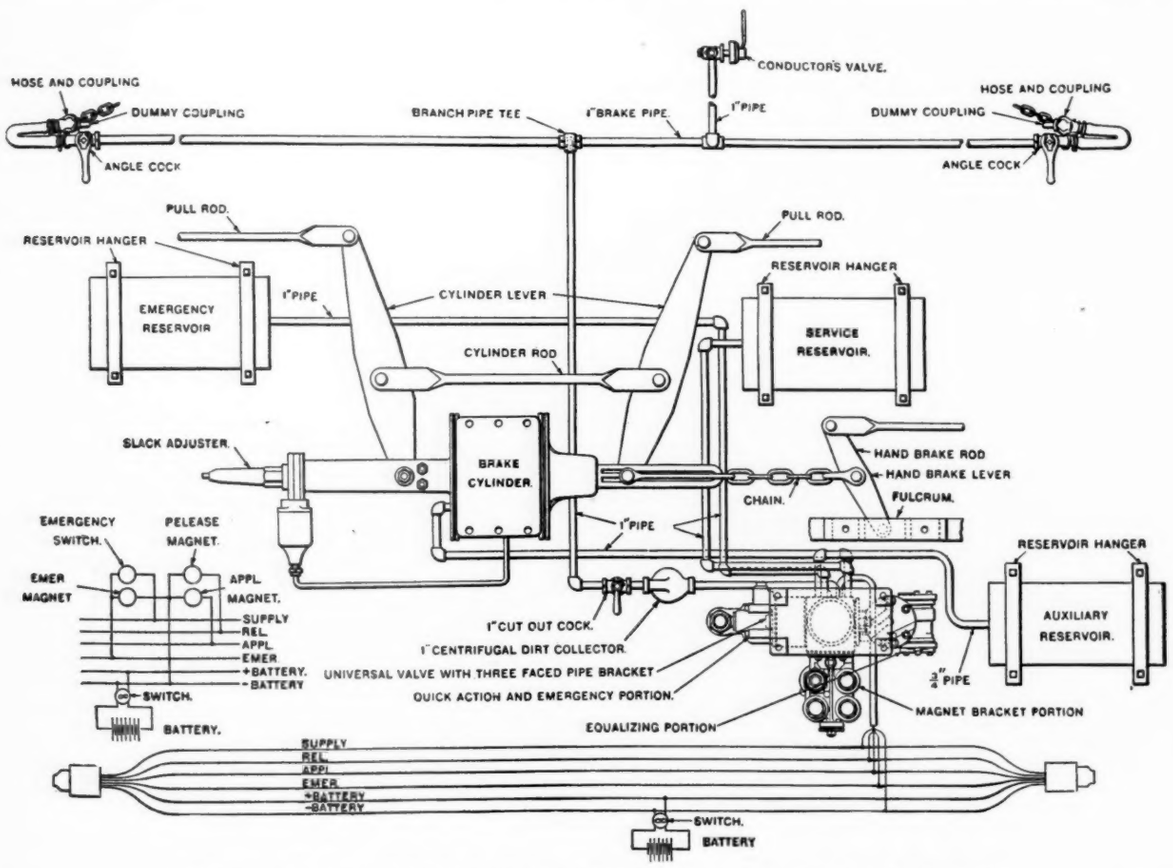


Diagram of the Complete Westinghouse Electro-Pneumatic Brake (U C Equipment)

*Sections of the complete paper have been eliminated in this article.

eration to the controllable factors mentioned in order to compensate as far as possible for the unavoidable variations in brake shoe friction. That these variations have more than a merely nominal effect follows from the fact that the brake shoe, considered as an element of the mechanical system transforming the force of compressed air into retarding force at the rim of the wheels, is low in efficiency, averaging for stops from 60 m. p. h., in the neighborhood of 10 per cent. Consequently a slight variation in brake shoe performance can cause a considerable percentage of change in mean coefficient of brake shoe friction and a corresponding change in length of the stop, the latter being subject to a range of variation of as much as 20 per cent, or more *due to brake shoe condition alone.*

The object of the Pennsylvania Railroad tests of 1913 was to make as thorough a study as might be found practicable of the variables mentioned above and their effects, with particular reference to:

A A determination of the maximum percentage of emergency braking power which can be adopted, considering:

a The type of brake shoe to be used.

b The type of brake rigging to be adopted.

c The type of air brake mechanism and control to be adopted.

d The degree to which occasional wheel sliding is to be permitted under unfavorable circumstances.

e The variation in the condition of the rail surface for which it is considered necessary to provide.

B A comparison of the relative performance of the clasp brake rigging (two shoes per wheel) and the standard brake rigging (one shoe per wheel) with regard to:

a Maintenance of predetermined and desired piston travel.

b Efficiency of transmission of forces.

c Effect upon wheel journals, bearings and truck.

d Mean coefficient of brake shoe friction for the standard plain cast iron shoe.

C A comparison of the performance of the improved air brake mechanism (type UC) with that of the commonly used "high speed" (type PM) brake equipment with regard to:

a Efficiency and effectiveness, as shown by the length of service and emergency stops.

b Safety and protective features.

c Flexibility and certainty of response to any manipulation of the engineer's brake valve.

d Uniformity of action of individual equipments associated in the same train and of any individual equipment at different times.

e Smoothness of riding during stopping, slack action between cars, and the resulting shocks.

f Capacity for future requirements.

D The behavior of the brake shoes as the tests progressed and any variation in the results of similar tests which could not be accounted for by known changes independent of the brake shoe. One type of brake shoe was to be used throughout the range of the tests. Relating to objects *A*, *B* and *C*, advantage was taken of this opportunity to establish as definitely as possible the characteristics of this type of brake shoe under the influence of various combinations of speed, pressure, time, weather and the conditions of the brake shoe.

E The coefficient of friction between the wheel and the rail under varying weather conditions.

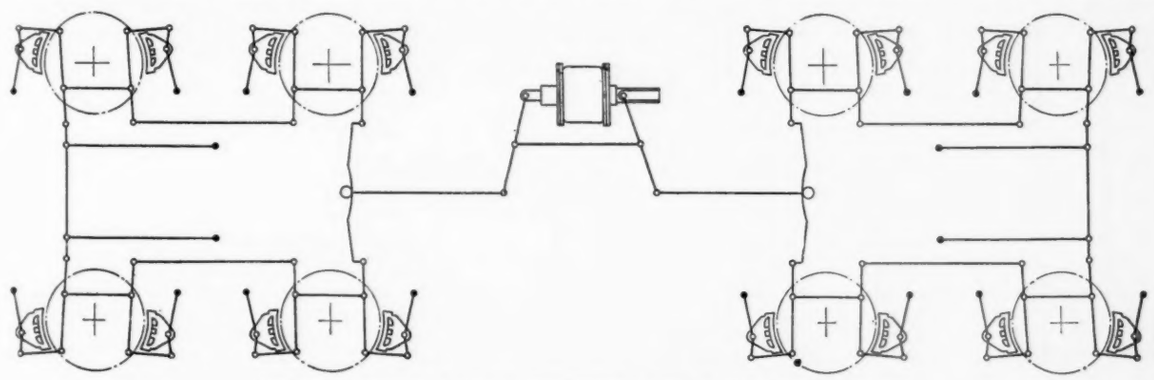
In addition to the investigations outlined in general above, it developed during the tests that additional data were desired regarding the performance of brake shoes under certain specific conditions. In consequence a series of experiments was carried out at the laboratory of the American Brake Shoe and Foundry Company, at Mahwah, N. J.

FEATURES OF EQUIPMENT AND APPARATUS TESTED

The tests of the standard (type PM) air brake equipment were planned to determine the characteristic performance of this type of equipment throughout the range of service and emergency operating conditions typical of the ordinary service in which this equipment is in general use in order to bring out its limitations and serve as a standard of reference to measure the betterment made possible by the improved features of the new air brake apparatus, the more efficient design of foundation brake rigging and more satisfactory brake shoe performance.

The special features of the improved air brake equipment (type UC) which received more or less attention during the tests may be summarized as follows:

A The electro-pneumatic brake equipment is adapted to meet any requirement, from that exemplified in the PM brake equipment to the more exacting requirements of present conditions, with a degree of efficiency as high as the existing physical conditions will permit.



Outline Diagram of Lever Arrangement on No. 3 Clasp Brake Rigging

B Considering cylinder pressure alone the equipment may be installed so as to produce any desired pressure, either in service or in emergency.

C The gain by use of the electric control, in addition to the pneumatic, is the elimination of the time required for the pneumatic transmission of the action of the brake from car to car and, in addition the elimination of shocks and uncomfortable surging which results from the non-simultaneous application of the brakes on all cars.

It is apparent that the gain from the electro-pneumatic control is not so much in the shortening of the stop, particularly in emergency, as it is in the increased flexibility and certainty of control of the brake and the assurance that modern long heavy trains can be handled smoothly and accurately.

D The troubles and inconveniences due to brakes failing to release, as well as the undesired application of brakes due to unavoidable fluctuations of brake pipe pressure when running over the road, are eliminated.

E An adequate supply of air is available at all times.

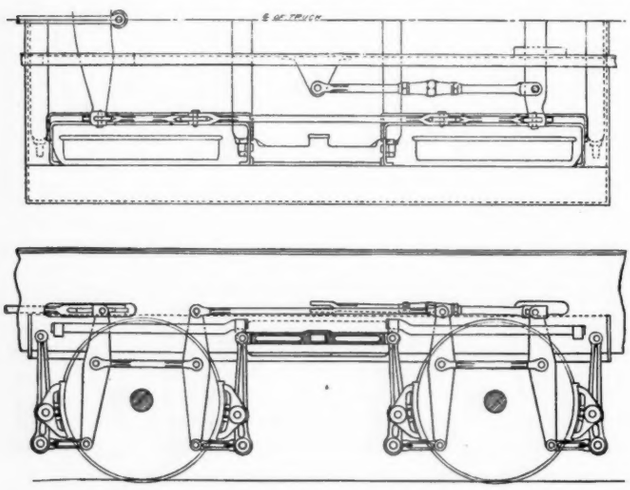
F The emergency braking power is available at any time, even after a full service application of the brake, since it is impossible for the engineman to use up the reserve emergency pressure without making an emergency application.

G The equipment is adaptable to all weights of cars and

to any desired percentage of braking power. Two brake equipments for heavy cars are not necessary nor are two service brake cylinders required, except for cars weighing more than the limit of the service capacity of one brake cylinder. Provision is made for using one brake cylinder up to the maximum percentage of emergency braking power which it can provide, and for using two cylinders when a higher emergency braking power is desired. When using one brake cylinder, the maximum service pressure is controlled by means of a safety valve. When two cylinders are used, equalizing pressure from 110 lb. brake pipe pressure is utilized for the service brake (instead of blowing the air away at a reducing valve) and another brake cylinder is used for the additional power required in emergency applications. The use of one or two cylinders is optional, depending upon the amount of braking power to be employed.

Duplicate tests were made with the clasp brake rigging, two shoes per wheel, for every test made with the standard brake rigging, one shoe per wheel, in order to bring out the advantages of the clasp brake in the following desirable features: (*A*) constant piston travel for all cylinder pressures; (*B*) smoothness of action during stopping; (*C*) greater certainty of obtaining and maintaining the predetermined braking force contemplated in the design of the air brake equipment and foundation brake rigging; (*D*) less displacement of journals, bearings and trucks, tending toward greater mechanical efficiency and less cost of maintenance; (*E*) a coefficient of friction equal to or greater than that with the single shoe brake with less wear of brake shoe metal and lower wheel and brake shoe temperatures.

The original plan contemplated two 12-car trains of standard P-70 steel passenger cars. These cars have 4-wheel trucks with one 16-in. brake cylinder per car. One train was equipped with the clasp type of brake rigging (two shoes per wheel) and the other with the type of standard brake rigging (one brake shoe per wheel) existing on these cars since they were



Brake Rigging Referred to as No. 3 Clasp Brake

built, but modified by increasing the strength of the members to be suitable for 180 per cent braking power which necessitated lowering the brake shoes 1⅛ in. below their former position and by anchoring the truck dead lever to the car body, instead of to the truck.

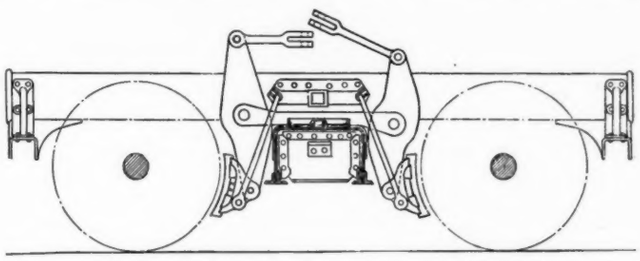
In order to obtain the best data possible, instruments were devised for taking records of the friction of the rail, wheel sliding, retardation of the train, and slack action between cars as well as for a number of minor observations.

The test train was 1,040 ft. long, consisting of a Pacific type locomotive and tender of the P. R. R. K2s class, weighing, in working order, about 200 tons, and 12 passenger cars averaging about 61 tons each.

The ET air brake equipment was used without any modification on the locomotive, except that in some tests an auxiliary device was used which increased the braking power obtained during the early portion of the stop.

The cars were equipped with the present standard air brake apparatus (PM) and with the improved type of air brake equipment (UC), these installations being so arranged that a complete change from the standard equipment (PM) to the new equipment (UC) having PM features only or the complete pneumatic features of the new equipment or to the new equipment with complete electrical control could be quickly made.

The standard plain cast-iron brake shoe was used in most



Brake Rigging with One Shoe to Each Wheel

of the tests. In several tests flanged, slotted and half area shoes were employed. Special care was taken to insure uniformity in quality and the condition of all shoes at the beginning and during the progress of the tests.

The high-speed reducing valves of the PM equipment were adjusted to open at 62 lb. brake cylinder pressure.

The standing piston travel was adjusted before each run to 6½ in. with a full service brake application.

The tests were made on the southbound track of the Atlantic City Division of the W. J. & S. R. R. The portion of the track over which the braking was done was level, and part of a tangent about 25 miles long terminating at Absecon Station. A slight descending (0.3 per cent) grade approaching the measured test track was in favor of the train attaining speed. The point at which the brakes were applied was 2,880 ft. north of mile post 9.

The track for a distance of 5,000 ft. south of the zero point was wired for circuit breakers, which were placed at intervals of 25 ft. up to 1,200 ft. from the zero point, and at intervals of 50 ft. from there on to the 5,000 ft. point. Preceding the zero point, eight circuit breakers were located, 66 ft. apart from which the initial speed of train (speed at the trip) was determined.

A cabin, located near the zero circuit breaker, contained the clock and chronograph from which in connection with the track circuit breakers, the speed of the train before and during the stop was obtained.

After each test measurements were taken of the total length of the stop, and also the running piston travel on each car.

Of the devices used on the track, the only one which requires special mention is the machine that was used to measure the force required to move or keep moving a block of tire steel resting upon the rail. The pressure of this block on the rail could be varied by means of weights of 20, 40, 60, 80 and 100 lb. Readings were taken with each of these weights and the coefficient of rail friction recorded was derived from the average of the five readings.

FEATURES OF THE UC EQUIPMENT

The manner in which the functions of the universal control equipment are performed is described in full in the report of the tests. The valve mechanism which is the distinguishing feature of this equipment is of the "built-up" type which makes it possible to install and operate this equipment if desired in stages, by adding to the simplest arrangement of apparatus, including only those features required to give an operation

equivalent to that of the PM brake, up to the complete form of the device.

The UC equipment, in its complete form comprises a valve mechanism called the *universal valve* with its permanent pipe bracket and three reservoirs, the auxiliary, the service and emergency reservoirs.

The universal valve consists of an equalizing portion, which primarily controls the charging and recharging of the reservoirs of the equipment, the service application of the brakes and the releasing of the brakes.

A quick action portion with high pressure cap, which controls the transmission of serial quick action and obtaining of high emergency pressure in the brake cylinders when an emergency application of the brakes is made.

An electric portion, which comprises the magnets, switch, etc., controlling the electric service application, electric release and electric emergency applications of the brakes.

A pipe bracket, to which all pipe connections are permanently made and to which the various portions of the valve device are bolted. This bracket contains two small chambers, the quick action chamber and quick action closing chamber.

The quick action closing chamber provides means whereby the quick action outlet from the brake pipe to the atmosphere is open when an emergency application is made and is closed when a predetermined time thereafter has elapsed.

The quick action chamber in connection with the quick action closing chamber controls the operation of the quick action parts of the valve in accordance with the rate of brake pipe reduction.

In addition to the above the equipment on each car comprises:

An auxiliary reservoir which is the same size for all sizes of brake cylinders, the pressure in which controls the movement of the equalizing piston and slide valve of the universal valve and supplies air to the brake cylinder.

A service reservoir which varies in size with the size of the brake cylinder. This, together with the auxiliary reservoir, supplies air for operating the brake cylinder in service and emergency brake applications.

An emergency reservoir which varies in size according to the size of brake cylinder used and the amount of emergency brake cylinder pressure which the installation is designed to afford. This reservoir supplies the air required to graduate the release of the brakes and to obtain quick recharging of the service and auxiliary reservoirs after a service application of the brakes. It also provides the additional supply of air required to obtain the increased brake cylinder pressure desired for emergency applications.

The valve mechanism is designed to require a drop in brake pipe pressure of approximately 4 lb. before it is possible to obtain an application of the brakes. The equalizing piston moves on a differential much lower than this, however, so as to close the feed groove and thus prevent back leakage from the auxiliary reservoir. Thus a service application of the brakes is positively insured when the required 4 lb. brake pipe reduction is reached. From this point the rise in brake cylinder pressure corresponds to the reduction in brake pipe pressure in the proper relation to produce a full service brake application (90 per cent. braking power) for a brake pipe reduction of 24 lb.

GENERAL DISCUSSION OF STOPS

By reason of the many combinations of conditions under which different tests were run, including different types of air brake equipments, methods of applying the brakes, nominal per cent of braking power, types of brake rigging, brake shoe conditions, speeds and train make-up, a great variety of general comparisons might be made to illustrate the effect of these various conditions singly or in combination on the length of stop and the behavior of the trains during stopping. It will be possible to point out in this paper only the more significant and important comparisons which emphasize the salient features of the tests.

The shortest 60 m. p. h. emergency stop was made with a single car (locomotive not attached) with the No. 3 clasp brake electro-pneumatic equipment, 180 per cent braking power, and flanged brake shoes. The car was stopped under these conditions in 725 ft. The average retarding force for this test was 332 lb. per ton. This is equivalent to the resistance offered by a 16.6 per cent grade on which one end of a P-70 car (80 ft. long) would be 13.3 ft. higher than the other end.

This stop of 725 ft. from 60 m. p. h. made with a modern heavy passenger equipment car establishes a new record for a railway car stop.

Assuming a rail adhesion of 25 per cent, the shortest possible stop which could be obtained, by utilizing this adhesion to its maximum throughout the period of braking, would be 481 ft. This would require an ideal brake shoe and a controlling mechanism which would automatically adjust the retarding force of the brake, so that it would be at all times the maximum which could be used just short of producing wheel sliding.

The shortest 80 m. p. h. stop was made, with conditions the same as mentioned above, in 1,422 ft. This is equivalent to an average retarding force of 310 lb. per ton.

From the data of stops made with locomotive alone and single car breakaway stops it is possible to calculate the approximate length of stop which would be obtained with a locomotive and train of twelve cars equipped with the electro-pneumatic brake

Calculated from the results of single car breakaway tests, the best 60 m. p. h. train stop that could have been obtained with the means available during these tests is about 800 ft. and the best 80 m. p. h. stop about 1,570 ft.

The shortest 60 m. p. h. train stop with a locomotive and train of twelve cars was 1,021 ft. This was made with high braking power on the locomotive and No. 1 clasp brake, electro-pneumatic equipment, 180 per cent braking power and plain shoes on the cars.

The shortest 80 m. p. h. train stop was made in 2,197 ft. with high braking power on the locomotive and with No. 1 clasp brake, electro-pneumatic equipment, 150 per cent braking power and plain shoes.

BRAKE SHOES

The condition of the material in the brake shoes, the manner in which they are adjusted to fit the wheel, and the bearing which the shoes have on the wheel will materially influence the length of stop, having the greatest effect at the higher speeds. These agencies, although previously observed and recognized in a theoretical way, had never been so forcibly impressed upon observers as during the present series of tests and the information gained from the performance of the brake shoes in the tests has developed some noteworthy facts in regard to them.

CONCLUSIONS

In service applications with the improved (UC) equipment a greater flexibility of operation is provided. That is, the braking power per pound of brake pipe reduction is lower, thus giving the engineer a greater time in which to use judgment when manipulating the brakes. At the same time, however, the maximum braking power obtainable in a full service application is higher.

A more sensitive and prompt release of the brakes is insured, tending to improve the releasing action of all brakes in the same train of mixed old and new equipments.

The action of the old and the new equipments mixed in the same train is harmonious and free from rough slack action or shocks both in service and emergency operation.

The UC equipment is adaptable to any weight of car and may be installed to furnish any desired nominal per cent of braking power.

With the new equipment operating electrically or pneumatically, there is always available a quick acting and fully effective emergency brake. This is not the case with the old equipment, in which the relation of the service and emergency functions

is such that a quick action application could not be obtained after a service application of any consequence. The following average results indicate the degree to which this difference has an effect on the length of stop. Considering the ordinary full service stop from 60 miles per hour with both brakes (say 2,000 or 2,200 ft.) as 100 per cent, the attempt to make an emergency application with the old equipment does not produce any shorter stop than if only a full service application were made. With the improved apparatus operating pneumatically, an emergency application following a partial service application will shorten the stop about 14 per cent and after a full service application about 10 per cent.

With the electro-pneumatic brake these figures are respectively 23 per cent and 15 per cent.

An electrically controlled brake application has been recognized as ideal ever since the report to this effect presented by the Master Car Builders' Committee in charge of the famous Burlington Freight Brake Trials 1886 and 1887, for the reason that thereby the time element in starting the application of the brakes on various cars in the train is eliminated, a correspondingly shorter stop made, and the possibility of shocks at any speeds removed. With the new brake apparatus the effectiveness of the pneumatic emergency application is so considerably increased that the saving in time due to electric control has proportionately less influence on the length of stop, but its effect in eliminating serial action and consequently the possibility of shocks due to brake application is of importance.

The graduated release feature of the improved brake apparatus permits stops to be made shorter, smoother and with a greater economy in time and compressed air consumption.

The new apparatus can be applied to give only the equivalent of the old standard apparatus if desired but in such a form the complete new apparatus can then be built up by the addition of unit portions to the simplest form of the mechanism.

The electro-pneumatic brake acts as an automatic telltale in cases of malicious or accidental closing of an angle cock after the train is charged by permitting all the brakes to apply, it being thereafter impossible to release the brakes behind the closed cock until the cock is opened.

The PM equipment will start to apply on a brake pipe reduction of 2 lb. A 4-lb. brake pipe reduction is required to start an application with the UC equipment, thereby preventing undue sensitiveness to application on slight, unavoidable fluctuations in brake pipe pressure. As a bona fide service reduction of more than 4 lb. continues, the rate of attainment of braking power is the same as if no stability feature had existed.

The attainment of full service braking power on the entire train with the UC equipment operating pneumatically was 16 seconds, 33 per cent longer than with the PM equipment because of the smaller size reservoirs used for greater flexibility.

Full service braking power was obtained in nine seconds with the electro-pneumatic power, but without sacrificing desirable flexibility because of the increased sensitiveness of control.

The time of transmission of serial quick action through the brake pipe is practically the same with UC and PM equipments.

The time to obtain full emergency braking power with the PM equipment on the entire train was 8 seconds; with the UC equipment operating pneumatically 3.5 seconds or 56 per cent shorter; with the electro-pneumatic equipment 2.25 seconds or 72 per cent shorter.

With the electro-pneumatic brake a uniform increase in per cent of braking power results in a substantially uniform decrease in length of train stop. An increase of 5 per cent in braking power reduces the length of stop about 2 per cent within the range of braking powers tested.

The available rail adhesion varies through wide limits, e. g., from 15 per cent in the case of a frosty rail early in the morning to 30 per cent for a clean, dry rail at mid-day.

The amount of wheel sliding depends more on the rail and weather conditions than on the per cent braking power. Some sliding was experienced with braking powers as low as 90 per cent and 113 per cent where rail conditions were unfavorable, but 180 per cent braking power did not cause wheel sliding with good rail conditions.

The effect of excessive wheel sliding was to make the length of the stop about 12 per cent greater than similar stops without wheel sliding.

Brake Rigging.—An efficient design of brake rigging must be produced before the advantages of improved air brakes or brake shoes can be fully utilized.

The use of the clasp type of brake rigging eliminates unbalanced braking forces on the wheels and so avoids the undesirable and troublesome journal and truck reactions that come from the use of heavy braking pressures on but one side of the wheel. This has an important effect not only on freedom from journal troubles but also in enabling the wheel to follow freely vertical inequalities of the track.

The clasp brake also improves the brake shoe condition materially, both as to wear and variability of performance.

Although the clasp brake rigging will produce better stops than a single shoe brake rigging equally well designed (other conditions being equal), its advantage in this direction is of less importance than in the improved truck, journal and shoe conditions mentioned above.

The tests indicated that at least 85 per cent transmission efficiency could be obtained with either single shoe or clasp brake rigging.

The following features were observed to be of importance if maximum overall brake rigging efficiency is to be secured:

(*a*) Protection against accidents that may result from parts of rigging dropping on the track.

(*b*) Maximum efficiency of brake rigging at all times to insure the desired stopping with a minimum per cent of braking power.

(*c*) Uniform distribution of brake force, in relation to weight braked, on all wheels.

(*d*) With a given nominal per cent braking power, the actual braking power to remain constant throughout the life of the brake shoes and wheels.

(*e*) Piston travel to be as near constant as practicable under all conditions of cylinder pressure.

(*f*) Minimum expense of maintenance and running repairs of brake rigging between the stopping of cars.

Length of Stop.—The stops and observed performance of the air brake, brake rigging and brake shoe are in agreement with the relation generally assumed to exist between the speed and other variables mentioned and resultant length of stop. This relation for straight, level track and neglecting air and internal friction on the one hand and the rotative energy of the wheels and axles on the other hand, is:

$$S_t = 1.467Vt + \frac{V^2}{30Pef}$$

in which the terms have the following significance and range of values according to conditions

S_t = length of stop to be expected in ft.

V = initial speed of train in m. p. h.

t = time at the beginning of the stop during which the brakes are to be considered as having no effect, to allow for the time element in the application of the brakes.

		Kind of Air Brake Equipment	
For a 12-car train		PM	UC Electro-Pneumatic
t ranges	from	2.0	0.70
	to	2.5	0.85

P = nominal per cent braking power corresponding to the average cylinder pressure existing for that portion of the stop after the brake is considered fully applied.

With a single car or several similar cars, stopping without the locomotive attached, the value of P can be obtained from an average of all brake cylinder indicator cards or taken from one typical brake cylinder card, provided all cylinder pressures and foundation brake installations are substantially alike.

SHOP PRACTICE

REPAIRING SLIDE VALVE FEED VALVES

BY J. A. JESSON
Air Brake Foreman, Louisville & Nashville, Corbin, Ky.

The successful working of the feed valve depends principally on the fit of the piston and supply valve. It is essential that the cylinder and valve bushings be in alinement and that the fit of the piston in its cylinder be accurate.

The drawings show a method developed by the writer for this class of work that is giving good results. It can be used in places where special power machines are not available.

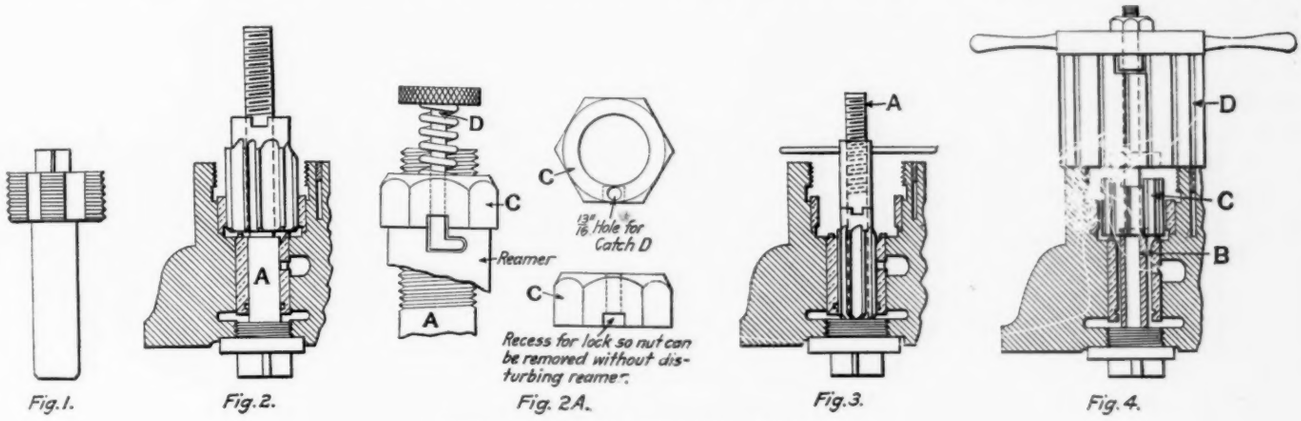


Fig. 1. Fig. 2. Fig. 2A. Fig. 3. Fig. 4.

Method of Repairing Slide Valve Feed Valves

The cylinder bushings are counterbored and cut off the correct size in a lathe. The slide valve bushings have the valve over lap groove and the counterbore on the boss end made preferably in a lathe, as neither of these operations interferes with the finished product, provided proper dimensions are adhered to.

The tap shown in Fig. 1 is used for extracting the old cylinder bushing. One end is made so that it forms a guide for the tap and is a close fit in the slide valve bushing. The tap is then run into the cylinder bushing a sufficient number of turns to secure a good grip on the bushing, which is then forced out by striking the guide.

When boring the cylinder bushing it is rough reamed to within about 0.002 in. of the size of the piston to be used, then finished to size as shown in Figs. 2 and 2A. The reamer is placed on pilot *A*, which is screwed into the tapped hole at the back of the feed valve. The reamer and the feed nut *C* are connected by catch or lock *D*, as shown, to prevent the reamer from traveling too fast. A wrench is used on the nut for turning the reamer. When through reaming, the catch is turned until the spring draws it clear of the reamer into the recess in the nut. The threads on the pilot are 20 per inch; the reamer has a 1 in. straight hole. It is essential that the reamer be fed slowly on fine cuts.

Fig. 3 shows a 1⅛-in. shell reamer with a ⅝-in. straight hole, working over a pilot, which is fastened to the feed valve as indicated in Figs. 2 and 2A. This is used to finish the valve bushing, which is forced in with the inside diameter smaller and the bosses on the end longer than standard so they may be finished to standard dimensions. After the inside diameter of the bushing has been finished, the reamer is removed and a thimble is put over the pilot. This is of such length that when 1/16 in. is removed from the bosses by the 1⅝-in. end mill *C* shown in Fig. 4, the thimble will fit bare on the face recessed in the end of the mill. An end mill *D* is used for facing off any irregularities on the end of the body to which the cap nut fits. This mill has a 1-in. hole and should be operated on the pilot shown in Fig. 2, being shown in Fig. 4 as a matter of convenience. It is turned by a handle which fits in the key way as shown and is fed by the nut *C*.

A jig for truing up the feed valve piston is shown in Fig. 5, in which *A* is a steel cylinder; *B* is a similar piece which fits closely in *A*; *G* is a split bushing and is used for holding the piston central in *B*; and *C*, *D*, *E*, *F* and *P* form a combined tool and post. The tool *D* is ¼ in. in diameter, flattened on the upper side for the set screw *E*, and is operated by the feed screw *F*,

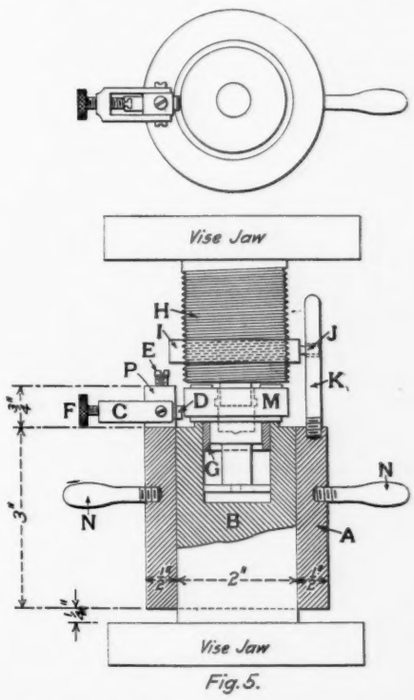


Fig. 5.

Part of the Equipment for Repairing Slide Valve Feed Valves

which is swivelly connected. A threaded block *H* carries a nut *I*. The ends of the block *H*, and piece *B* are clamped between vise jaws. This holds the piston *M* tight against the end of *B*;

the nut *I* is held by the pin *J*, which fits in a hole in the post *K*, the latter being screwed into *A* as shown.

Turning *A* with the four handles *N* causes the nut *I* to feed the cylinder *A* until the tool has cut across the face of the piston; it can then be reversed without moving the tool. The block *H* is 1⅝ in. in diameter by 1⅝ in. long, and has 20 threads per inch.

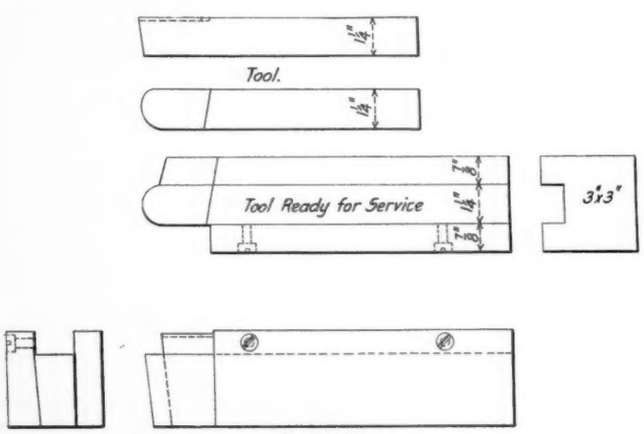
The piston will usually true up to about 0.005 in. or 0.006 in. less than the old size. An assortment of reamers is used, ground in dimensions of thousandths of an inch, beginning at 0.005 in. less than 1¾ in., and so on. To finish the cylinder for the new standard piston a reamer 1¾ in. plus 0.0005 in. is used. Whatever diameter the piston trues up, a corresponding size of reamer can be used for finishing the cylinder fit.

Templates should be kept for measuring the various sizes of pistons. An easy way to make them is to bore out old feed valve cap nuts and screw them into the body, then bore them out with the different size reamers, the same as in boring the cylinder bushings. Where a piston fits a template slightly loose a good method is to heat the feed valve body around the bushing. This will cause it to expand slightly; then bore while it is hot, and when it cools off it will be slightly smaller than if bored cold.

IMPROVED TOOL HOLDER AND CENTER FOR WHEEL LATHES

BY C. M. NEWMAN
General Foreman, Atlantic Coast Line, South Rocky Mount, N. C.

The turning tools used on large wheel lathes are generally made from the best grade of high speed tool steel and are so large that they are very expensive. The accompanying engravings illustrate a tool holder made at the Atlantic Coast Line shops at South Rocky Mount, N. C., which uses 1¼ in. by 1¼ in. high speed tool steel. This holder has been tested on ten pairs of driving wheel tires by using it in one post and a tool made of the same make and grade of steel, but 1½ in. by 3 in., in the other post. The service rendered by the smaller

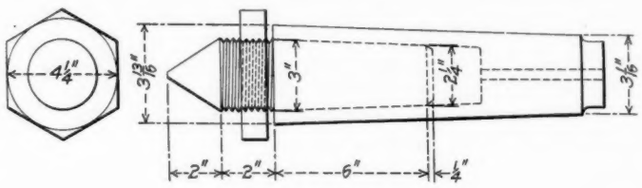


Right Hand Tool and Holder for 80 in. Wheel Lathe

steel in this holder was equally as good as that of the larger tool. It is also easier for the machine operator to handle the lighter tools, and the cost of maintenance is less than that of the heavy ones.

The greatest benefit to be derived from the use of this holder and the smaller steel is in the cost of applying a set of new tools. To equip a machine with a set of two roughing tools, ready for service, made of 1½ in. by 3 in. by 24 in. high speed tool steel costs approximately $36, while a set of two roughing tools made of 1¼ in. by 1¼ in. by 24 in. high speed tool steel costs approximately $14, a saving of $22 on a set. When the tools are worn to as short stock as can be used, about 7 in., we have in one case two pieces of 1½ in. by 3 in. by 7 in. steel worth about $10, and in the other case two pieces of 1¼ in. by 1¼ in. by 7 in. steel worth about $3.60, or a difference of $6.40 in the value of the scrap. This steel can, of course, be reclaimed and used on smaller machines.

A set of two of these tool holders can be made for about $8, including labor and material. Adding this to the cost of the tools gives a total cost of $22 for the smaller tools and the



Center for Wheel Lathe

tool holders, which is $14 less than the cost of two roughing tools made of 1½ in. by 3 in. steel.

It will be seen from the construction of the holder that the cutting edge of the tool is well supported. To remove the tool from the holder and the holder from the post is not any more difficult than to remove the large solid tool. The tool holder can also be used on boring mills and other heavy machines, and can be made to carry other styles of tools by changing the shape of the supporting end. If used on boring mills the holders should be made the same size as the tool steel originally used.

We have at times had the ends of the centers of wheel lathes broken due to excessive strain or to rough usage on the part of the operator. When an accident of this nature occurs it requires the removal of the end cap and screw in order to take out the broken center from the spindle and apply another, consuming from two to three hours of the operator's time as well as delaying the work on the machine. The other illustration shows an improved center which is now being used, and which, if broken, can be removed by a turn on the pull nut without removing any part of the machine, and another center can be quickly applied. In addition to the time saved by this change there is quite a saving in material when it is necessary to make a new center. The original centers were made of tool steel at an approximate cost of $10 each. This improved style of center is made of tool steel at an approximate cost of $2 for material, or a saving of $8 for each center. The sleeve or bushing which carries the center is made of mild machine steel, and after application always remains in the spindle.

Size of Exhaust Nozzles.—An account of experiments on locomotive blast pipes or exhaust nozzles and funnels is given by G. Strahl in the *Zeitsch. des Ver. deutsch. Ingen.* for November 1. The experiments were conducted with stationary and moving locomotives on the Prussian State Railway, and confirm in general the theory of Zeuner upon which the formulas which are at present in use for the calculation of the funnels and blast pipes of German locomotives are based. He finds, however, that the diameter of these parts of the engine should be a litle greater than that given by Zeuner's theory. He finds that this increase in their dimensions does not interfere with the full draft of the locomotive. In practice the best funnel—that is, the one which permits the employment of the blast pipe of largest diameter—usually requires a space between it and this blast pipe impossible to realize on account of the limited dimensions of the smoke box. In this case, the blast pipe should be placed as low as possible, and should have the maximum diameter compatible with that of the exhaust ports so as to give a funnel as large as possible.—*The Engineer.*

TOOLS FOR LOCOMOTIVE REPAIRS

Attachments for Work on Eccentrics and for the Operation of Air Motors in Close Quarters

BY R. S. MOUNCE

MANDREL FOR TURNING ECCENTRICS

The mandrel shown in Fig. 1 is used for turning eccentrics on a boring mill. Two lines are laid off on the table and through the center of the machine, at right angles to each other. Two studs are applied on one of these lines at distances of 9 in. and

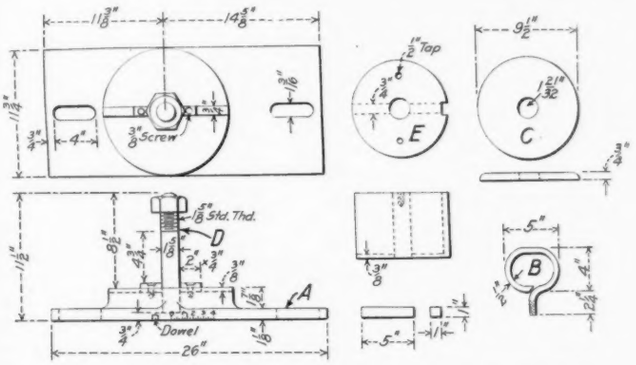


Fig. 1—Mandrel for Turning Eccentrics on a Boring Mill

12 in. each side of the center, for the purpose of holding the base A of the mandrel on the boring mill table. The other line forms an index for setting the mandrel by means of the scale on the side of the base to any desired throw. With the spacing of the holding studs, together with the slots in the

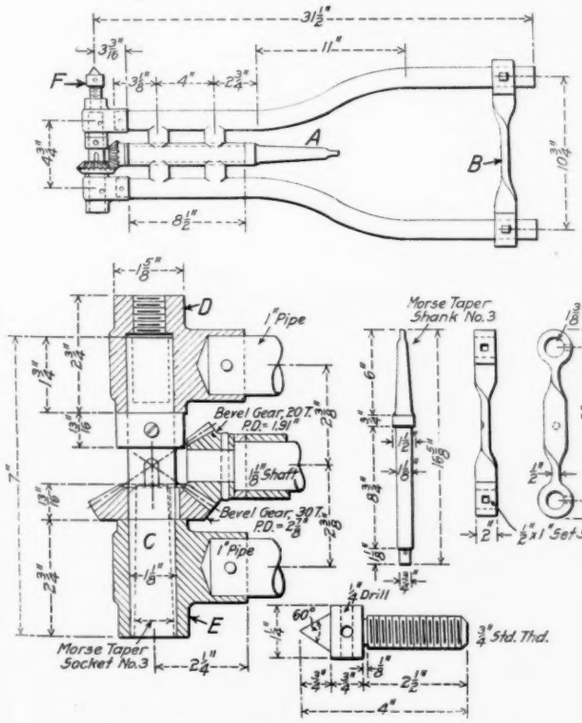


Fig. 2—Right Angle Attachment for Air Motors

base of the mandrel, any throw from 4 in. to 9 in. may be obtained, which more than covers all the sizes of locomotive eccentrics. The scale is graduated in quarter inches, and the setting is always equal to one-half the throw. Several sizes of mandrels E are required with this apparatus to fit the several sizes of eccentrics. The mandrel has a keyway, which fits over the two small keys on the boss of the mandrel base; it also has a keyway corresponding to the keyway in the driving axle, so that eccentrics may be keyed in place on the mandrel, thereby insuring accuracy in turning. Handles B are provided to facilitate applying or removing the mandrel from the base. After the eccentric has been applied and keyed to the mandrel, there remains only to place the cover plate C over the bolt D, and to tighten the nut, drawing the whole securely together.

CLOSE QUARTER ATTACHMENT FOR AIR MOTORS

By means of the device shown in Fig. 2, drilling and reaming can be done with an ordinary air motor in as limited a space as with a specially designed close quarter motor. The attachment shown in the drawing makes the purchase of close quarter motors almost unnecessary; it is not a costly apparatus to

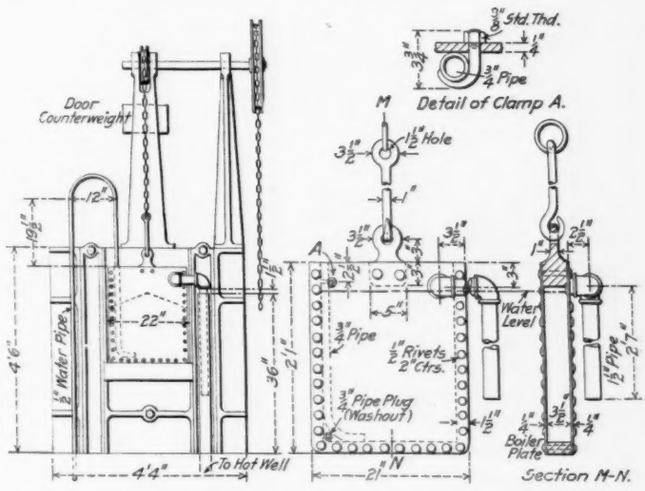


Fig. 3—Water Jacket Door for Oil Furnace

make, nor is its maintenance expense high, provided it is given sufficient lubrication and is handled with reasonable care. The air motor is attached to the driving shaft A, and is held in position by the cross bar B. This shaft rotates in a brass tube, which is brazed to the frame of the apparatus; and the bevel gear at its extremity mates with another bevel gear on the spindle C. The spindle revolves in the bearings, D and E, which are brazed and pinned to the ends of the frame. It is bored to take a Morse taper shank No. 3, and is provided with a drift-key slot to permit of backing out the drill or reamer. The other end of the spindle is cupped out so that the feed screw F may have a reasonably long travel. It is well known that the speed of air motors is rather high for large sized drills or reamers. An advantage of this close quarter attachment is that the bevel gears may be designed so as to give a considerable reduction of speed. By changing the dimensions of all parts as far as may be necessary, an attachment may be constructed for several sizes of motors and for the corresponding sizes of drills and reamers.

IMPROVED DOOR FOR OIL FURNACES

A water front door is shown in Fig. 3 as applied to a Ferguson spring banding oil furnace, although it may readily be applied to any similar forging furnace. It is operated the same as the cast

iron, fire brick lined door with which the furnace was originally equipped. It is so designed that, regardless of the position of the door, cold water is always flowing in and hot water flowing out. The ¾ in. intake pipe is clamped in the water front, as shown, so that the cold water enters at the bottom of the door.

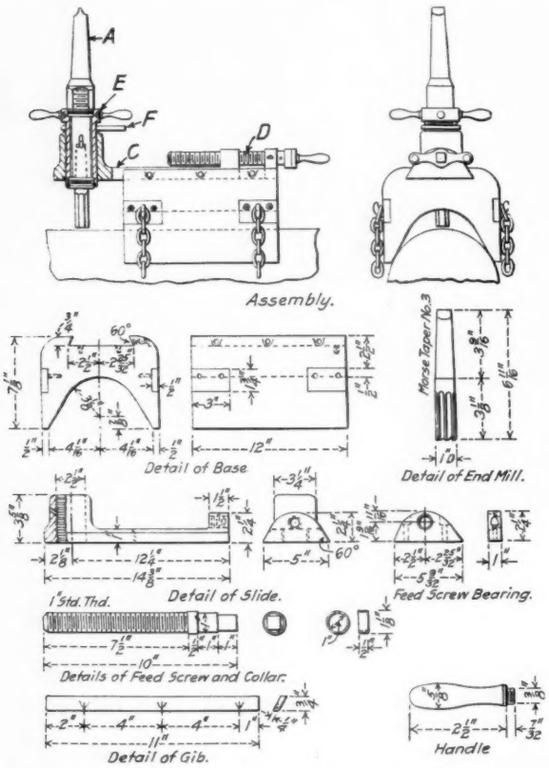


Fig. 4—Air Driven Milling Cutter for Cutting Eccentric Keyways

The ½ in. feed pipe is small enough to pass freely into the intake pipe and when the door is at its lowest position, the end of the feed pipe is 1½ in. below the top of the intake pipe. The 1½ in. overflow pipe is tapped in the outer door sheet, near the top, sliding freely in the 2 in. drain pipe, and when the door is at its highest position, the overflow pipe is several inches below the top of the drain pipe. The construction of the door is quite simple. The inner and outer sheets are made of ¼ in. boiler plate and are riveted to a frame of 1½ in. by 3½ in. bar iron with tar paper between the frame and the sheets. At one of the lower corners, a ¾ in. pipe plug is provided for the purpose of washing out the water front. The water never reaches the boiling point and there is no waste, as the hot water flows to a hot well from which the water is drawn for washing locomotive boilers. This improvement was devised by T. J. McCann, blacksmith shop foreman at the Cleveland shops of the Erie Railroad.

MILLING ECCENTRIC KEYWAYS

The details and assembly drawings of a device for milling eccentric keyways in axles are shown in Figs. 4 and 5. It is driven by an air motor which fits on the spindle *A*. The body of the jig fits over the axle and is rigidly held to it by chain clamps which extend around the axle. These clamps consist of a bar *B*, Fig. 5, swung from hooks in the side of the jig body by chains. A 1 in. set screw passes through the clamping bar bearing on the under side of the axle and is used to do the actual clamping. The air motor and milling tool are carried on one end of the slide *C*, Fig. 4, which is fed in and out by the feed screw *D*. The milling tool is raised or lowered through the screw bearing *E* and when correctly located is held by the lock nut *F*. The method of operation is briefly as follows: The device is centered in relation to the indicated location of the eccentric keyway, and is then rigidly fastened to the journal by means of the chains and clamping device. The driving power is furnished by an air motor attached to the driving spindle, which transmits motion directly to the end mill. It is generally advisable to drill a clearance at each end of the keyway, thereby making the work of the end mill easier. In milling the keyway, the end mill is lowered a suitable amount by means of the vertical feed screw and is held rigidly in its vertical position by the lock nut. By turning the crank in the proper direction, the cut is taken the length of the keyway. The mill is again lowered and the cut is taken across in the opposite direction, and so on until the keyway is completed. Feeding is, of course, all done by hand, but a set of keyways can be laid out and milled completely in from seven to nine hours.

ABOLISHING DEAD BUFFERS IN ENGLAND.—Beginning January 1 no dead buffer vehicles have been run on the railways in England and Wales. In Scotland the conversion is to be completed by the end of 1915, and the traders have been informed that all dead buffer wagons must be converted into spring buffer wagons by that date.—*The Engineer.*

SELF-PROPELLED CARS.—On many railways abroad the self-propelled car has been in use for a long time. In accordance with the former state of engineering knowledge, most of these cars used to be steam cars. It is only lately, in consequence of the progress made in electrical science and of the resulting enormous development of tramways, and of the improvements made in internal combustion motors, that a number of other types appeared, which have many advantages as compared with steam cars. It is no doubt due to this that rail motor cars have come into extensive use.—*Bulletin of the International Railway Congress.*

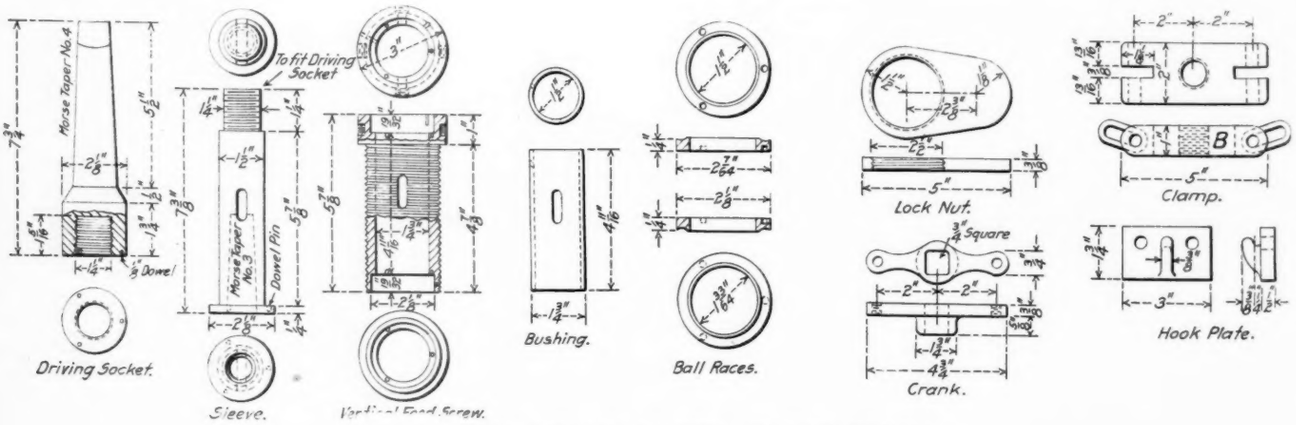


Fig. 5—Details of Machine for Milling Eccentric Keyways

INSTALLATION AND MAINTENANCE OF ELECTRIC HEADLIGHT EQUIPMENT

BY V. T. KROPIDLOWSKI

VI

In this, the last article of the series, the writer will deal with the steam turbine, taking up only those principles that are essential to the proper care and operation of a turbine of this kind. Some knowledge of its main principles on the part of the reader will be assumed.

The principle upon which the turbine operates is quite generally understood, but it may be well to refer to the reasons why steam acquires such a great velocity as compared with water. The law of gravitation governs in this case, as elsewhere. In order to impart motion to a body or mass there must be a difference of level, or pressure, and the greater the difference the greater will be the velocity. The formula for the velocity acquired by a falling body is $V2gh$, where g represents the force of gravity, 32.16, and h the height, or head, through which the body falls. The height of a column of water equivalent to a pressure of 50 lb. is, $50 \div .4335$ (the weight of a cubic inch of water) and the height of a column of steam at that pressure, assuming that the density of the steam remains constant is $\frac{144 \times 50}{.1533}$, in which 144 is the number of square inches in a square foot and .1533 is the weight of a cubic foot of steam at 50 lb. gage pressure. The heads, therefore, are respectively, 116 ft. and 47,032 ft. The velocity of the water is, $V64.32 \times 116 = 86.5$ ft. per second, and of the steam, $V64.32 \times 47{,}032 = 1{,}798$ ft. per second. These velocities, of course, are theoretical.

A question that is often asked is, "Why is the efficiency of the headlight turbine so low?"; or to put it in more usual form, "Why does this turbine consume so much steam compared with larger turbines?" There are many factors to be considered, but the principal reason why a small turbine or any other prime mover cannot be made as efficient as a large one is because, to begin with, the large unit does not work at 100 per cent efficiency and therefore when the size is reduced the efficiency must be considerably less.

The principal loss in a steam turbine is the rotation loss of the wheel revolving at high speed in certain atmospheric conditions inside the turbine casing. In a large machine this amounts to only 1 or 2 per cent, whereas in a small one it might be as high as 20 per cent or more. A further heavy loss in a turbine of the single or double wheel impulse type is due to the speed. In order to absorb all the velocity from the steam jet, the buckets in this turbine would have to travel at such a rate of speed as would be entirely impracticable. This residual velocity which the steam has after leaving the last bucket is the other great cause for inefficiency in a small turbine. Furthermore, there is only a very small portion of the periphery of the wheel utilized, while in a large machine the total circumference is used. Another thing that is not taken advantage of in the operation of small turbines is the condenser, which is the most effective agent in reducing the steam consumption when it is remembered that there is as much power in steam in expanding from atmospheric

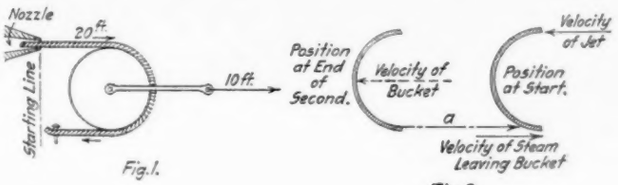


Fig. 1. Fig. 2.

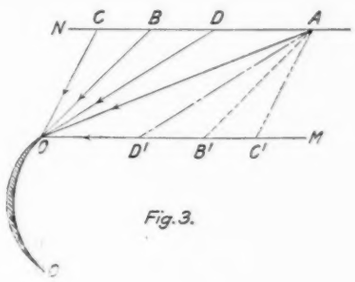


Fig. 3.

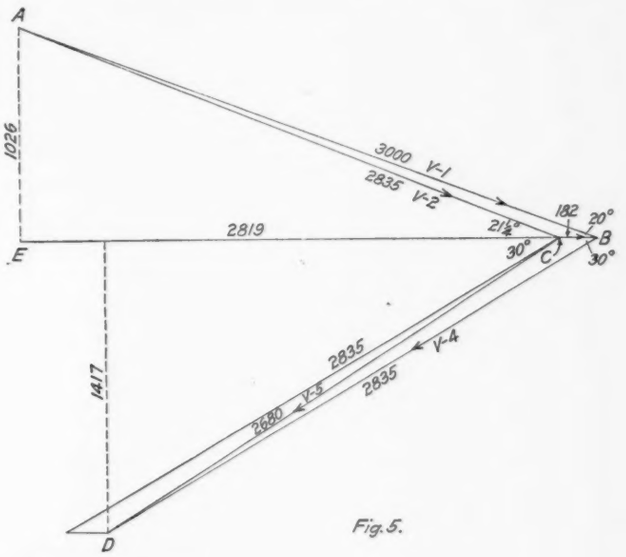


Fig. 5.

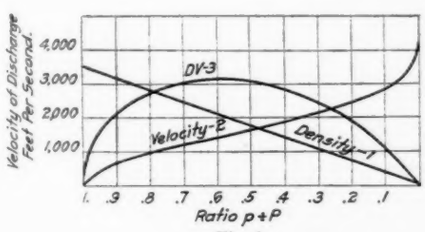


Fig. 4.

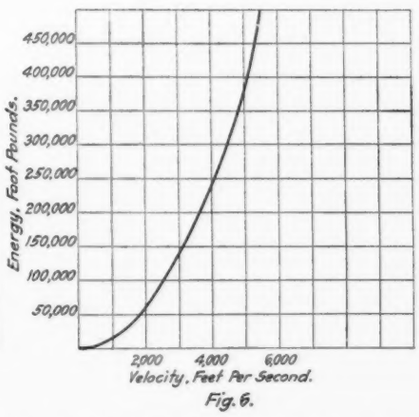


Fig. 6.

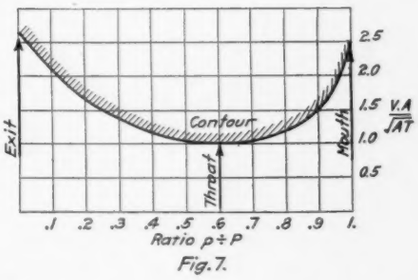


Fig. 7.

Diagrams for Use in Electric Headlight Turbine Calculations

pressure down to 27½ in. of vacuum as there is from 150 lb. down to atmospheric pressure. By using Carnot's formula, $\frac{T_1-T_2}{T_1}$, where T_1 is the absolute initial temperature of the steam entering a heat engine and T_2 the temperature of the steam leaving, we can see that the lower the exhaust temperature the more work will be obtained from the steam.

The inefficiency of the turbines used for electric headlights, aside from the unavoidable features mentioned above, is also largely due to the necessity of making a cheap machine in order to keep the price down to an amount which the railway companies are willing to pay. By the machining of the surfaces in the wheel and the addition of other refinements, a much more economical machine could be produced. Even a reasonable increase over the price of the present headlight turbine would produce a machine that would run on 80 lb. or 100 lb. of steam per horse power hour, as against the present consumption of 175 lb. to 200 lb. Dull bucket edges, as furnished in the small jobbing machines, also cause a loss, as do also the rough surfaces of the bucket walls and nozzles, and of the sides

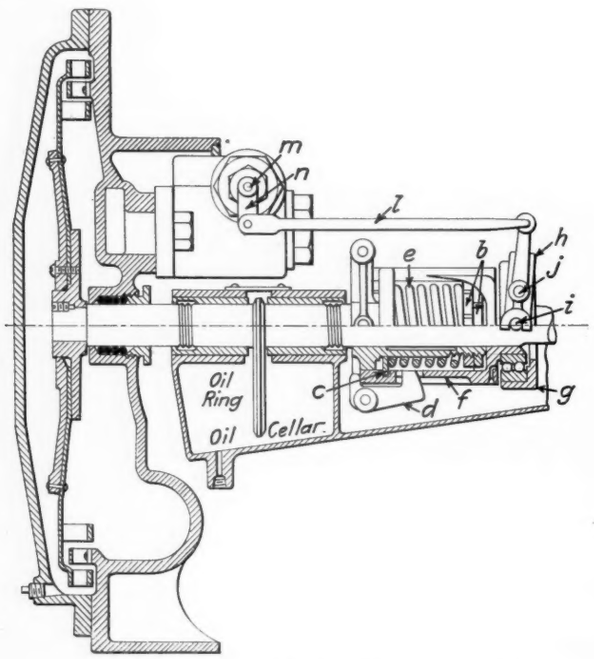


Fig. 8—Turbine End of American Generator

of the wheels. All these losses are much greater in a small machine than in a large one.

In an impulse turbine the periphery, or we will say a point, such as a bucket on the wheel, must travel half as fast as the steam that issues from the nozzle in order to be able to absorb all the velocity from the jet. When this condition is fulfilled the steam will have no velocity in relation to the stationary part of the turbine, and it will merely be paying out like a rope from a reel, as illustrated in Fig. 1. In an ideal turbine, the buckets would be shaped as in Fig. 2, so as to completely reverse the direction of the steam, but in practice they cannot be so shaped for the reason that the steam leaving the buckets would strike the backs of the other buckets, as indicated by the arrow *a*, Fig. 2. To avoid this they are shaped similarly to the bucket *oo*, Fig. 3.

Let us now take a concrete case and see what the possible efficiency would be. Assuming an initial pressure of 200 lb. per square inch and a final pressure of one atmosphere, the ratio of the pressures is .075. From Fig. 4 we find that the velocity of the jet from a properly designed nozzle, with no nozzle losses, is 3,000 ft. per second. Laying this off to scale, so that the length will represent the 3,000 ft. per second, and making an angle of 20 deg. with the line *E-B*, which represents the wheel, we will call this V_1, Fig. 5. Then AE = 3,000 sin. 20 deg. = 1,026, and BE = 3,000 cos. 20 deg. = 2,819; whence CE = 2,819 — 182 = 2,637; CB is the peripheral speed of a 14 in. turbine wheel under these conditions and is 182 ft. per second. The angle ACE, which the relative velocity, AC, of the steam makes

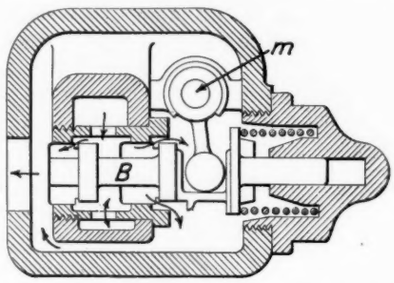


Fig. 9—Section Showing Valve of American Generator

with the plane of rotation, is the angle whose tangent is 1,026 ÷ 2,637 = .388; the angle is 21.25 deg. The relative velocity V_2 is 2,637 ÷ cos. 21.25 deg. = 2,835 ft. per second. Now assuming no loss by reason of the shock at the entrance to the blade, due to the steam striking on the edge, and neglecting friction losses, the steam will leave the blade with a relative velocity of 2,835 ft. per second and at an angle of 30 deg. (the blade angle) with the plane of rotation. The triangle of velocities at the exit is then represented by BCD, and V_3, the actual velocity of the steam

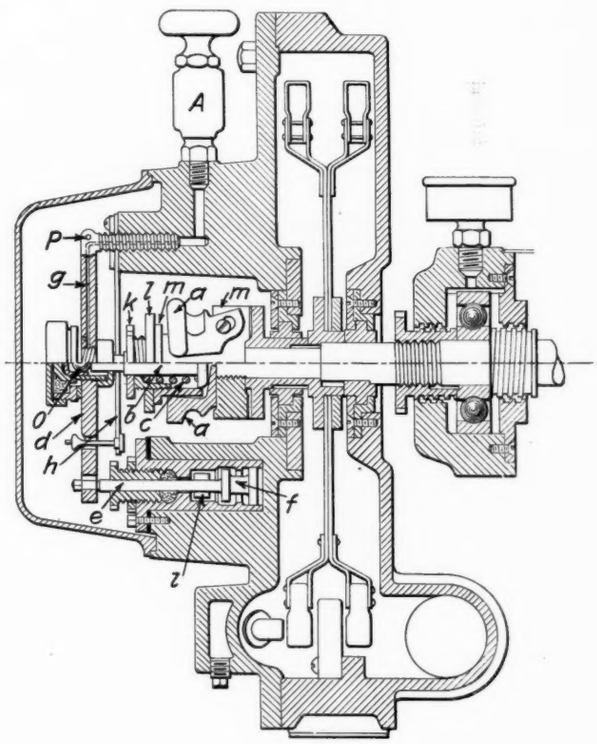


Fig. 10—Turbine End of the Schroeder Generator

leaving the wheel, is 2,680 ft. per second. The maximum possible efficiency in this case is then $\frac{3{,}000^2-2{,}680^2}{3{,}000^2}$ = 20 per cent, nearly.

But most of the turbines use the steam twice, that is, the jet is re-directed against the wheel, and in that way the remaining velocity is reduced. By repeating the process of calculations,

we obtain for the absolute velocity of the steam leaving the wheel 2,074 ft. per second, the efficiency being increased to about 50 per cent.

If we now wish to know the possible steam consumption of the turbine we can get at this in the following manner: The steam pressure at which these turbines are usually worked in actual service is about 150 lb. and by referring to Fig. 4 we ascertain that steam expanding from 150 lb. down to atmospheric pressure (the ratio of $p \div P$ being .09) has a velocity of approximately 2,933 ft. per second. From Fig. 6 we learn that the energy due to this velocity is about 132,500 foot-pounds. Of course the quality of the steam is not 100 per cent., but will be somewhere near 96 per cent, reducing the energy to 127,200. Furthermore, the nozzles used in these turbines are not perfect, and we will assume the efficiency of the nozzle to be 60 per cent. so that the available energy is again reduced to

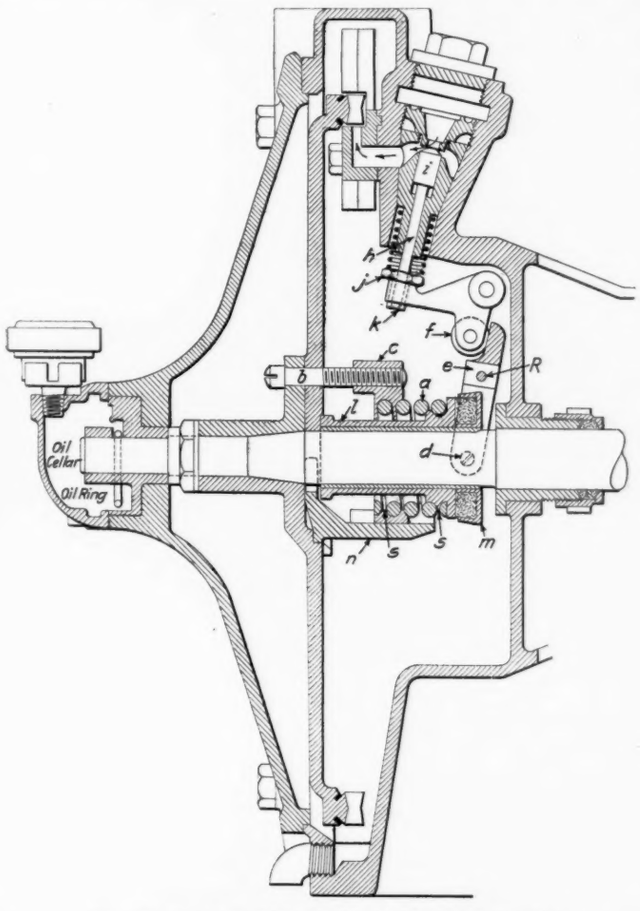


Fig. 11—Turbine End of Pyle-National Generator

76,320 foot-pounds. As mentioned before, the windage and friction losses of the wheel in a small turbine of this kind amount to about 25 per cent, reducing the efficiency of the turbine to $50 \times .25 = 12.5$, and $50 - 12.5 = 37.5$ per cent, the turbine utilizing 37.5 per cent of the available energy, 76,320 foot-pounds, which amounts to $76{,}320 \times 37.5 = 28{,}620$ foot-pounds. The theoretical steam consumption per horse power house is then $1{,}980{,}000 \div 28{,}620 = 70$ lb., 1,980,000 being approximately the foot-pounds per horse power hour. This would be very economical for a turbine of this kind, but from actual tests it is found that these turbines consume from 180 lb. to 200 lb. of steam per horse power hour. The actual efficiency, therefore, if we take the higher rate of consumption, is $70 \div 200 = 35$ per cent; and 35 per cent of $37.5 = 13$ per cent, which is the actual efficiency. The efficiency loss due to mechanical construction is, therefore $37.5 - 13 = 24.5$ per cent.

It is essential that the turbine speed be kept up to its rating, not running below or above that speed to any extent. The steam pressure should also be maintained as specified by the manufacturers as by varying any of these the efficiency is impaired and steam consumption increased. This will be seen by referring to Fig. 3. For example, consider the actual velocity of the steam as constant and vary the speed of the wheel. Thus, let OO, Fig. 3, be the blade and BO the tangent to its curve at the point of entrance. Let AO be, to the same scale, the actual direction and velocity of the steam leaving the nozzle. Let MO be the direction of motion of the wheel. Draw AN parallel to MO and cutting the tangent BO at the point B. To prevent shock, the relative velocity of the entering steam must be in amount and direction that of BO. Completing the parallelogram $ABOB'$, $B'O$, equal to AB, is the proper speed for the wheel. For, if speed of the wheel be greater than $B'O$ as $C'O$, the parallelogram of velocity is $AC'OC$, and OC is the relative velocity of the steam, which will strike the back of the blade, wasting energy in a downward thrust on the shaft. The same will be true if the wheel is not running fast enough, and also if the velocity of the steam is varied by varying the pressure. From this it is seen that it is very important to maintain the speeds and velocities for which the turbine is designed. It is also important to see that the nozzle is properly designed, as

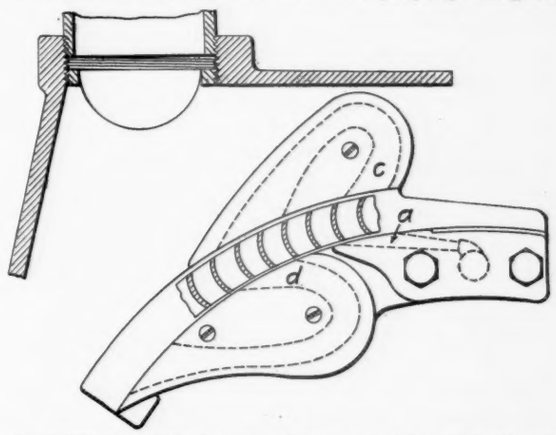


Fig. 12—Enlarged View of Steam Nozzle and Reversing Chamber of Pyle-National Turbine

upon it depends the velocity of the steam, and consequently the energy in foot-pounds. Wet steam should also be avoided, as it is very injurious to the buckets, wearing them out quickly.

There are various designs of nozzles, but a correct design is only produced after careful experiment. We know that with the convergent nozzle we can obtain just so much velocity and no more, and no matter how much we reduce the steam pressure at the exit end, or increase the steam pressure at the entrance end of the nozzle, we can obtain only the velocity due to the ratios of $p \div P = .58$, which is 1,446.5 ft. per second. But with a divergent nozzle we are able to obtain various velocities (within the limits, of course, of expansion) according to the design of the nozzle. Fig. 7 shows the theoretical half-contour of a divergent nozzle, which is calculated from the velocity and density when controlling its expansion gradually. All the data for this curve are obtained from Fig. 4.

The vital part of a steam turbine is the governor, and this and the bearings are the only things about the machine that demand the attention of the operator and attendant. If these features are properly looked after and maintained very little trouble will develop, aside from something unusual and unforeseen that may happen once in a great while.

Fig. 8 shows the turbine end of the American machine. The speed of this machine is regulated by screwing the two spanner nuts b either to the right or left, depending on whether it is running fast or slow. A very slight turn makes quite a difference in the speed. As the nuts are turned to the right they

compress the spring *e*, putting more tension on it, and the turbine must revolve faster in order to increase the centrifugal force of the weights *d* so they will be able to push the frame *f* against the tension of the spring. The operation of the governor is as follows: The weight *d* presses down with its heel on the end of the frame *f*. The plate *c* resists the movement of the frame due to the tension of the spring, but the centrifugal force overcomes it and the frame communicates its motion to the ball bearing case *g*, which in turn moves the yoke *h* by means of the pin *i*. The yoke *h* is pivoted to the main frame of the machine by the pin *i* and transmits the motion to rod *l*, which moves the arm *n*. The arm in turn revolves the shaft *m*, upon which is another arm inside the valve chamber; the inner arm is what closes the valve *B*, Fig. 9. Ordinarily the valve is open, due to the tension of the governor spring *e*, and the steam enters the passages to the nozzles as indicated by the arrows in Fig. 9.

The importance of maintaining the valve gear of this machine cannot be too strongly emphasized, as any lost motion in the pin connection has the same effect on the speed of the machine as increasing the tension of the spring of the governors, for the reason that the travel of the frame *f* must be greater to overcome the lost motion and, consequently the spring must be compressed to a greater degree, requiring more centrifugal force.

Fig. 10 is the turbine end of the Schroeder generator. To regulate the speed of this machine, loosen the nut *l* and screw the gland *k* to the left or right, according to whether it is desired to decrease or increase the speed. The operation of the governor is as follows: The centrifugal force throws out the weights *a* and the heels of the weights push on the arbor *b*. The spring *c* resists the movement of the arbor *b*, but finally it is overcome by the centrifugal force of the weights and the arbor *b* moves the steel plate *d* by exerting a thrust on the ball bearing *o*. Plate *d* being pivoted at *P* pulls on the valve stem *e* (the stem being part of the valve *f*) closes it and shuts off the flow of steam from chamber *i*, which communicates with the passage to the nozzle. In this connection it is well to draw attention to the necessity of making sure that lubricant is at all times in the cup *A*, and that the passages *g* are not obstructed with dirt. In one case the ball *o* was found welded to the end of the arbor *b*, due to the lack of lubrication.

Fig. 11 shows the turbine end of the Pyle-National generator. To regulate the speed of this machine, turn the two screws *b* (only one is shown) to the right or left as the case may be. One or two turns make considerable difference in the speed. The operation of this governor is as follows: Centrifugal force throws the weights *n* out (only one weight is shown) and their heels push on the end of the sleeve *l*. The tension of the spring *a* resists the movement of the sleeve *l* until the centrifugal force of the weights overcomes it, stretching the spring by means of the worm *s*, which is part of the sleeve and moves the round carbon casing *m*. This casing in turn moves the yoke *e*, which is fastened to it at *d*. The yoke being pivoted to the main casing of the machine at *R*, throws out the lower arm of the bell crank *f*, the upper arm of which pushes the valve stem *h* up and closes the the valve *i*. It is very important to see that the distance between the valve *i* and the seat is correct (the adjustment being made by nuts *j* and *k*) as, if the distance is too great, the turbine will speed up, because the sleeve *l* will have to travel farther and, consequently, the springs will have to be stretched more, requiring a greater centrifugal force. The opposite will be true if the distance is too small.

Fig. 12 is a larger view of the steam nozzle and reversing chambers of the Pyle machine. The steam leaves the nozzle *a*, impinges on the wheel buckets, flows into the reversing chamber *c*, is redirected on the buckets, as will be seen by following out the dotted lines, and leaving the buckets the second time, enters the chamber *d*.

SMITH SHOP TOOLS

BY J. F. PERRITT
Foreman Blacksmith, Seaboard Air Line, Jacksonville, Fla.

SHEARING DRAWBAR RIVETS

Fig. 1 shows a device for shearing rivets from drawbars that are to be repaired. It can be easily attached to a machine punch. This tool works so satisfactorily and is such a time and labor saver that it will pay for the trouble of making it in a very short time. Referring to the drawing, *A* is the main plate which is attached to the machine; *B* is a clamp to prevent slipping or turning; *C* is an adjustable slide to suit the width of the drawbar; *D* is the punch which is milled flat on one side and dressed as a side set; *E* are standards to support the clamp; *F* is a reversible handle for operating the clamp by a 1¼-in. screw, and *G* is the crank screw for operating the slide. In shearing, the rivet should be backed up by a guide to avoid springing. This guide can be attached in the same manner as the stripper used on a machine punch.

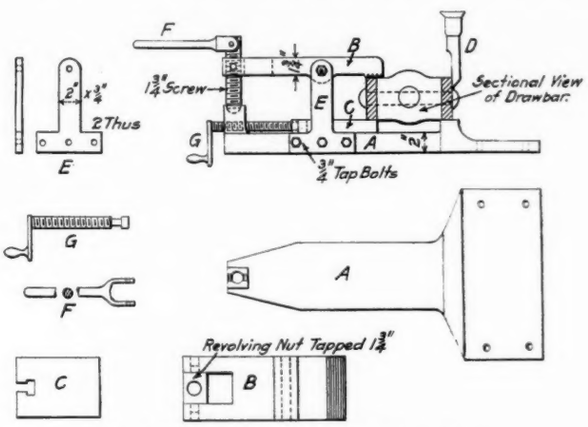


Fig. 1—Tool for Shearing Drawbar Rivets

TOOL FOR MAKING END DOOR HANGERS

Fig. 2 shows a tool used on an air machine for making end door hangers for freight cars. No sizes are given as they are governed by the hanger to be made. One application of the air completes the hanger. In operation, the long portion of the plunger *A* moves forward, forcing *B* over and forming the

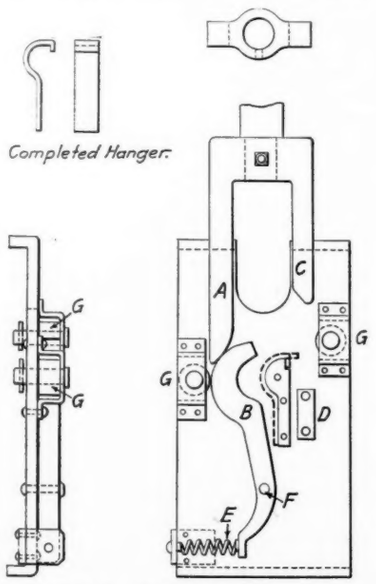


Fig. 2—Tool for Making End Door Hangers

bent portion of the hanger, as shown by the dotted lines. In moving forward, *C*, following *A* and *B*, completes the hanger by turning down the end. The coil spring *E* forces *B* back so that it is ready for the next operation. The loose rivet *F* acts as a pivot and the rollers *G* are to reduce friction on *A* and *C*.

PUNCHING OUT HINGES

Fig. 3 shows a tool used under a steam hammer for punching out hinges. No dimensions are given as these are regulated

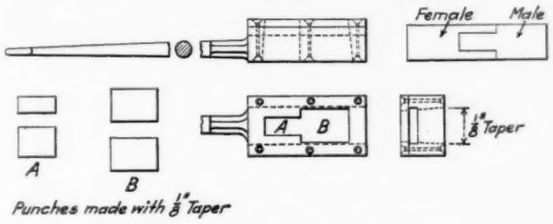


Fig. 3—Tool for Punching Out Hinges

by the hinges required. The punches are made exactly the same length and are placed in the tool as indicated by the letters *A* and *B*.

AUTOGENOUS WELDING IN LOCOMOTIVE FIREBOXES

BY N. H. AHSIUOLH

The firebox repairs, illustrated in this article, have had over six months' service and have developed no leaks or trouble of any kind due to the welding.

Fig. 1 shows the operation of welding a crack in a mudring in running repairs. This crack is shown in the sketch and developed about four months after the engine had received a general overhauling. All of the grates and frames, and one corner piece of the ash pan, were removed, and it was necessary to take out 12 corner mudring rivets and remove six staybolts. The corner pieces of the firebox side and flue sheets were cut

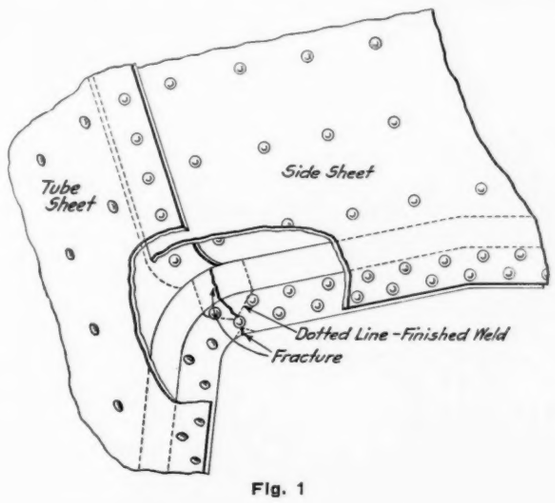


Fig. 1

out as shown, ground bevel along the cut out edge, annealed, and laid one side. The outside corner plugs of the throat sheet were removed to allow the mudring to expand and contract during the operation of welding. The mudring was chipped out in a V shape both ways from the bottom rivet hole. This opening was then filled in from the hole down to the bottom edge of the mudring, using the oxy-acetylene torch and ¼ in. swedish iron for flux. From the rivet hole to the top edge of the ring was next welded, filling in until the original thickness of the ring was restored. The weld was tested with a 20 lb. sledge after it was cold and developed no fractures. After chipping the face of the ring smooth, the old pieces of the side and flue sheets were bolted in place and welded. As the mudring contracted about ⅛ in. during the operation of welding the fracture, the outside corner of the throat sheet was refitted and corner plugs applied. The rivets and staybolts were then applied and no leaks developed at any of the welds during the hydrostatic tests. The entire operation consumed 35 hours, with a minimum amount of stripping. Three other engines, two of which

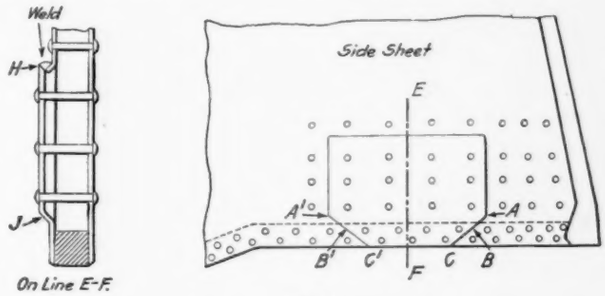


Fig. 2

had back corners fractured, have been repaired in the same manner, and have been equally successful.

In Fig. 2 is shown a patch applied to a right side sheet near the back mudring corner to renew a mudburned portion of the sheet. The side sheet was ripped out as indicated, and the edge of the old sheet from *A* to *A'* was flanged out toward the fire side as at *H*. From *A* to *C* and from *A'* to *C'* the edge was chipped at 60 deg. bevel on the fire side of the sheet. The patch was offset along a line from *A* to *A'* as at *J* and fitted up flush with the old sheet along the mudring to allow for the grate frames. The edge of the new patch from *A'* to *A* was chipped with a reverse bevel of 30 deg. as at *H*. The flush welds from *A'* to *C'* and *A* to *C* were first made, the old sheet being kept red hot at *B* and *B'* until the respective welds were completed, so that the draw resulting from the contracting of the welds in cool-

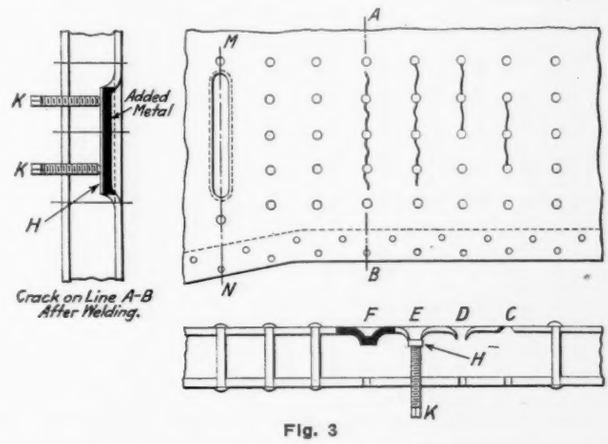


Fig. 3

ing would be in the old sheet, and not disturb the position of the patch. The box weld from *A'* to *A* was next completed and the rivets and staybolts applied.

In a patch of this kind the draw resulting from the cooling of the welds is at a right angle with the plane of the sheet. This draw keeps the patch tight against the flange of the old sheet, as a result of which it is not necessary to keep any clamps on the patch to hold it in position.

In Fig. 3 is shown a method of welding cracks in the side sheets of wide fireboxes. Cracks have been successfully welded in a number of side sheets, this particular illustration

showing the firebox of an oil burner which has had over six months' service since the welding of the cracks was completed.

There were four adjacent cracks in the right side sheet near the door sheet. The staybolts were removed and the cracks chipped out for their entire length as shown at *C*, leaving an opening about ¼ in. wide. The sheet was then heated with the gas torch for a distance of 1½ in. back from the edge of the chipped out portions, and bent in toward the water space as shown at *D*. This left an opening 1⅛ in. wide and the length of the crack, as shown on the line *MN*. A piece of ⅛ in. steel 1¼ in. wide, *H*, was then shaped to cover the opening *D*. This piece was placed against the edges of the opening on the water side, the hole in the outside sheet was tapped and the staybolt *K* run against the ⅛ in. piece to clamp it in position during the welding. The edges of the opening and the ⅛ in. piece were then welded, the opening being filled with iron from ¼ in. stick flux until the original ⅜ in. thickness of the sheet was obtained as at *F*. The staybolt holes were then drilled and the staybolts applied in the usual manner. This method has been standard with the writer, and has never resulted in a failure of any kind after the engine left the shop.

This operation of welding cracks illustrates further the idea of compensating for the contraction of cooling welds, by removing the area of contraction from the general plane of the side sheet, the contraction in this case being at right angles to the plane of the sheet, instead of in the same plane, as when flush welding of cracks is attempted.

In autogenous welds as made by the writer there is no preheating of sheets, nor are any preparations made other than to fit up the patches and sheets ready to weld. There is

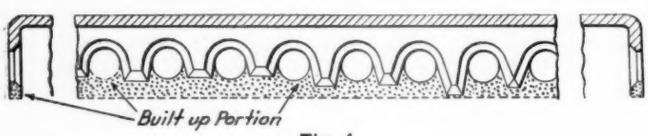


Fig. 4

no movement of any patch or sheet where the box weld is used and all the holes can be punched in the sheets before the welding. In patches where the flush weld is used the holes are generally left blank, and drilled after the welding is completed.

In oil burning locomotives, equipped with the front end burner, the top and side door sheet seams give much trouble by leaking, due to the intense heat in this part of the firebox. Repeated caulking in the roundhouse soon reduces the lap, as a result of which a new door sheet is often necessary when the engines are shopped. Since the advent of gas welding such repairs are made by chipping the flange holes in a V shape as shown in Fig. 4. The opening is then filled in to the edge of the lap with stick flux, made of sheared strips of forebox plate, 5/16 in. square. The holes are then reamed and countersunk, and rivets or patchbolts applied.

Precooling Perishable Freight.—The precooling of perishable freight before it is placed in refrigerator cars has become recognized as very desirable. There are certain classes of perishable freight, such as meats, dairy products, etc., with which it is absolutely necessary to do this. In these cases the precooling is usually done in cold storage warehouses, and the cars iced for a sufficient time before loading to insure the proper temperature inside the car when the products are loaded. In the case of fruits and vegetables, while precooling is very desirable, it is not absolutely necessary. A carload of fruit will probably take two or three days to reduce to the proper temperature if loaded without precooling, whereas by precooling either in the car or in the cold storage warehouse, this reduction of temperature may be accomplished in a much quicker time.—Railway Age Gazette.

THE APPRENTICE—A BOY

BY A. B. KERR
Instructor of Apprentices, St. Louis & San Francisco, Springfield, Mo.

Apprentice education is practically a new department of railroading, but it is a department of very great possibilities. While at present apprentice school instruction is generally given to only the boys in the mechanical department, yet the author believes that within the next decade, a broader scope of railway education will be developed in which practically all skilled employees will be under instruction which relates directly to their crafts.

However, the shop apprentice boy is at present quite a large enough problem. Since an apprentice is a boy, he is essentially an individual. All schemes of scientific management that have so far been developed for him have failed because of this fact. Apprentices may be required to pass standard examinations before entering their apprenticeship, they may be impartially and systematically corrected and graded by their foreman and by their instructor, they may be disciplined; yet the apprentice is still a boy. This nature requires that he be led. Each characteristic should be studied by his foreman and instructor and the knowledge and sympathy thus established used to lead the apprentice toward good and intelligent workmanship rather than to attempt to accomplish it by the use of an inflexible rod of discipline. When drawn along by the "different individuality" links he cannot swerve to one side but when pushed ahead he may suddenly swing out of the line of applied force. Every means should be used to find these qualities; his parents, associates and friends should be tactfully consulted with this one purpose in view.

Discipline is at times necessary and from the standpoint of the foreman and instructor it is becoming more necessary each year. There was a time, fast disappearing, when an apprentice was automatically disciplined by his fellow workmen. Before the days of apprentice schools and systematic management, the average journeyman considered himself an instructor in the mysterious art of his trade, the ritual consisting of knocks, jokes and ridicule. Very few books were written concerning his craft and how, the mechanic asked, could a boy learn anything unless he were impressively talked to over a vise or deep in a pit? This period has, however, about passed, and the journeyman now feels that it is the company's work to train the boys. Discipline should, therefore, also be administered by the company, but care must be exercised by their agent in its administration. He should be a man who is intimately acquainted with the boys and with the men, he should know each little peculiarity of his boys, their weaknesses and their ambitions. He should have the respect of the journeymen and the liking of the apprentices; he should be recognized as the source of grievance adjustment, and the company's friendly advisor for the boys. In short, he should be intelligently sympathetic, yet impartial and just. Thus armed, the agent is properly equipped to administer discipline.

In both shop and classroom instruction the foreman and the instructor should work together to bring home to the boy the prime principle of importance and thoroughness. It is a lamentable fact that at least three-fourths of the apprentice applicants who have been more or less educated in the public schools, have little knowledge of the principles underlying the studies in which they have been educated. Explain everything clearly; do not leave a boy in doubt regarding any operation or problem. Everything about the shop has a reasonable explanation, and it is essential to future advancement that the reason, not merely the "theory," be understood by the apprentice. By diagrams, and examples, if necessary, show just why a square foot is not a linear foot, and why it is a measurement of area. It is not necessary that explanatory titles be given to each branch of study,

but starting with the elementary principles of the work, the entire study should be fabricated into a structure of practical working knowledge. Create within the apprentice first a love of principle, then teach him the importance of accuracy, and finally develop speed. The function of the apprentice department is specific, yet general, for its influence often pervades the entire shop. Each apprentice system is a local one in detail, inasmuch as it must conform to the local conditions. No text has ever been prepared which successfully deals with the entire subject, for each apprentice is a boy on his own street.

DEVICES FOR SHOP USE

BY LeROY SMITH

MAGNETIC OLD MAN

The magnetic old man shown in Fig. 1 is made up of coils of an automatic motor starter, which had been discarded, into a form suitable for serving as a support for a small electric or air drill used for drilling telltale holes in staybolts in the boiler. The one shown is for use at 220 volts, direct current, and works best when the coils are in a vertical position.

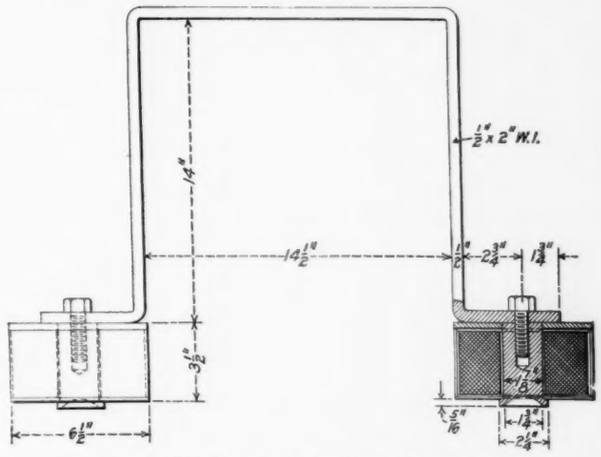


Fig. 1—Old Man Held in Place Magnetically

PORTABLE RIVET FORGE

A substantial portable rivet forge that may be made in almost any railway shop is shown in Figs. 2 and 3. The wheels are 15½ in. in diameter and the framework is so designed as to bring the forge up to a convenient height for the operator. The furnace is made of ⅜-in. boiler plate and has a wind guard extending half way around it. A screen of ½-in. boiler plate is placed in the bottom of the furnace through which compressed air is blown, giving the necessary draft to the fire. The air is taken in through the ¾-in. hose connection, as shown in Fig. 3 and regulated by a ½-in. stop cock. A pan 9 in. wide x 15½ in. long x 3¼ in. high, made of ⅛-in. steel plate, is fastened to

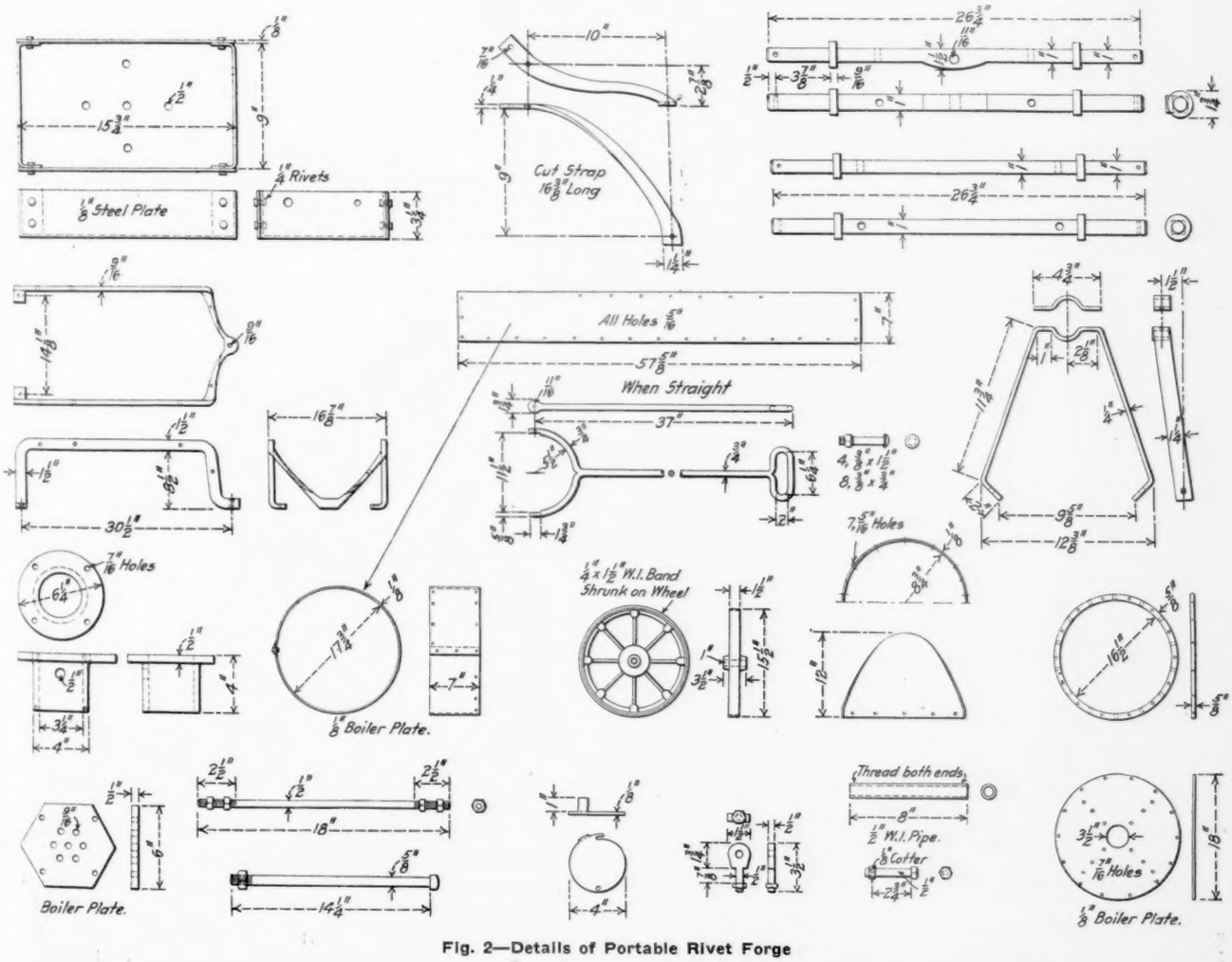


Fig. 2—Details of Portable Rivet Forge

the frame of the forge for carrying a quantity of cold rivets for the work at hand. There are five ½-in. holes drilled in the bottom to allow any water that may fall in the pan to drain

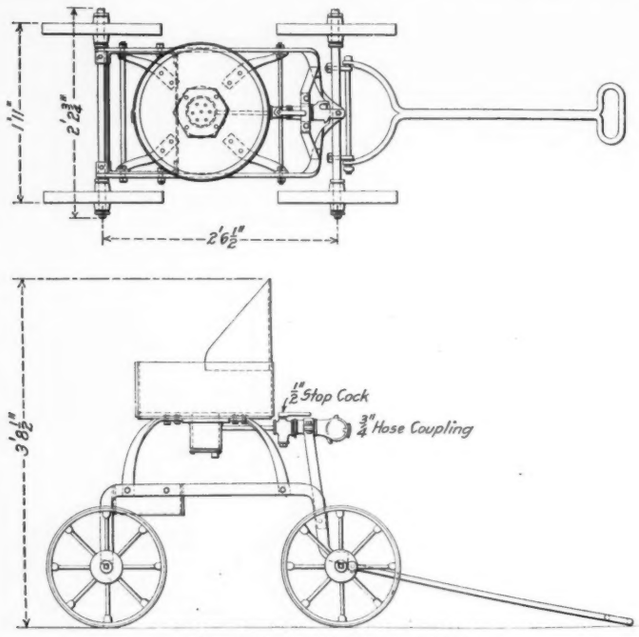


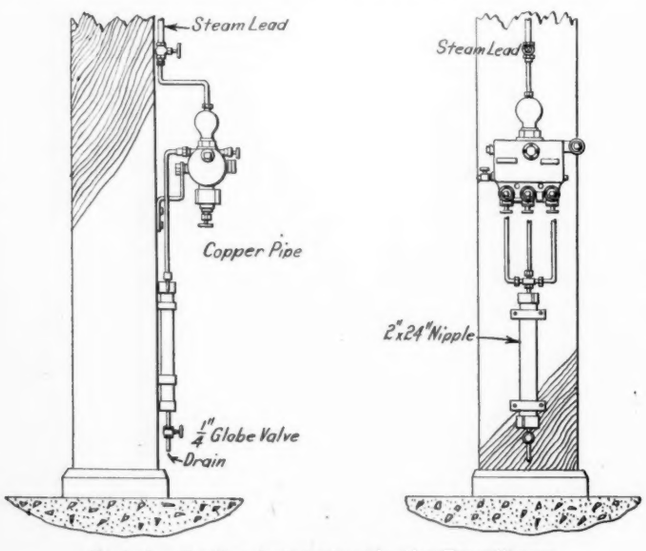
Fig. 3—Portable Rivet Forge

out. The working drawings and details are clearly shown in the illustrations.

ROUNDHOUSE TEST RACK FOR EXAMINING LUBRICATORS

BY F. W. BENTLEY, JR.
Machinist, Butler Shops, Chicago & North Western, Milwaukee, Wis.

A great deal of the running repair and overhauling work done on lubricators at roundhouse points is work about which the repairman is forced to draw his own conclusions as to the exact nature of the defects. This is for the most part due to the fact that the opportunity for examining the lubricator generally arrives after the locomotive has been housed and cooled down.



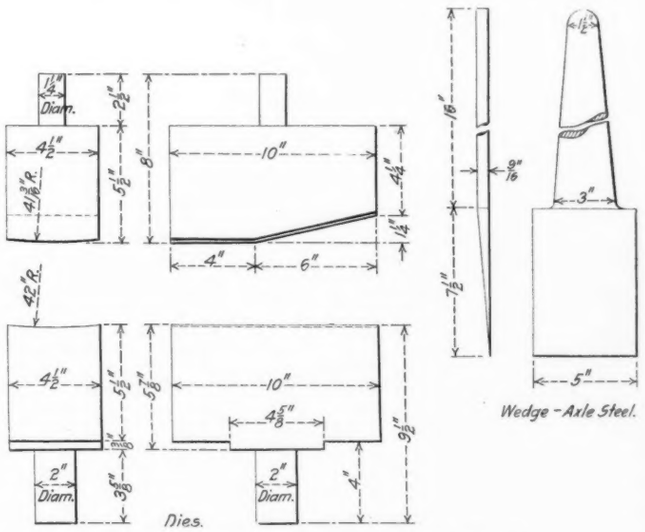
Rack for Testing Lubricators in the Roundhouse

The illustration shows a simple test rack which can be placed on any convenient roof support or post of the roundhouse. Steam can be obtained from a tap in the blower pipe which generally extends down the side of the post. With this arrangement the lubricators can be tested under nearly the same conditions as those under which they operate on the locomotive, and after an overhauling will reveal any leaking joints which may not have been properly or securely tightened; the condition of the feed nozzles, reducing plugs, gaskets, etc., can be ascertained before applying the lubricator to the locomotive.

TOOL FOR SETTING BOILER COURSE SHEETS

BY PAUL R. DUFFEY

In large locomotive boiler repair shops the setting of new boiler course sheets cannot be done without special forming devices. The tool shown in the drawing has been found to be very useful in this connection. The male die is inserted in the top of a press and the female die in the bed or plate.



Tool Used in Setting Boiler Course Sheets

The sheet is placed between the two dies and the wedge set in the proper distance, quickly and accurately giving the sheet the proper set. The dies and wedge should be made of a good grade of axle steel in order to successfully hold their shape under the required work. All of the parts should be machine finished.

Refrigerator Car Construction.—During the past three years 38,770 refrigerator cars were built by the private car lines and the railroads. The capacities of 7,000 of these were not obtainable. Of the rest, 3.3 per cent were of less than 60,000 lb. capacity, 57 per cent were of 60,000 lb. capacity, 8.2 per cent were of 70,000 lb. capacity, 25 per cent were of 80,000 lb. capacity, and 6.5 per cent were of 90,000 lb. capacity. Of the total of 38,770 cars, 21,941 were equipped with steel underframes; 12,448 were equipped with friction draft gear; 6,778 were equipped with spring draft gear; 3,932 were of all-wood construction, and 505 were of steel frame and underframe construction. The following table, giving the percentages of those cars, of which information could be obtained, that were constructed with steel underframes, friction draft gears, spring draft gears, and of all wood, shows clearly the recent tendencies in construction:

	1911	1912	1913
Steel underframe	44.3 per cent.	51.7 per cent.	79.4 per cent.
Friction draft gear	38.3 per cent.	8.8 per cent.	89.2 per cent.
Spring draft gear	22.4 per cent.	21 per cent.	0.2 per cent.
All wood construction	29.7 per cent.	3.2 per cent.	0.2 per cent.

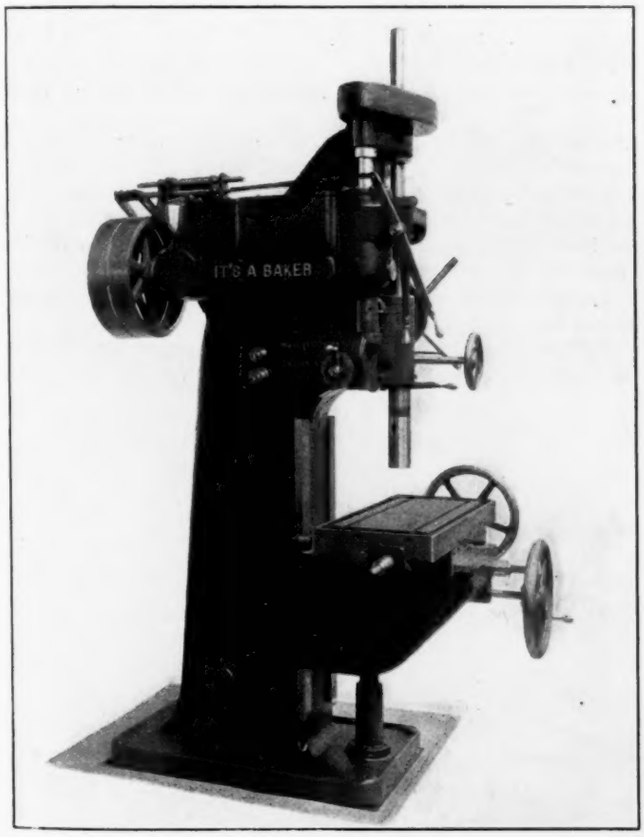
—*Railway Age Gazette.*

NEW DEVICES

HIGH SPEED DRILL

A high speed drilling machine which has a capacity for driving 2½-in. diameter high speed drills in solid steel has been developed by Baker Brothers, Toledo, Ohio, and is shown in the accompanying illustration. This machine is massive and powerful throughout and is provided with a full range of speeds and feeds for rapid work.

Changes are obtained through hardened sliding gears mounted on ball bearings which give high efficiency and great durability. With the driving pulley running at 500 r. p. m. there are six speeds to the spindle, as follows: 500, 369, 258, 179, 130, 92½. Any one of these speeds may be obtained instantly by means of sliding gears controlled by one lever within easy reach of the operator. The machine is so arranged that there are no idler gears running at any time and only one pair is in mesh at a time.



Ball Bearing High Speed Drill.

The gears in the train, except the large top driving gear, are of steel, oil treated and hardened. They run in baths of oil and are protected by suitable guards. The driving shafts are mounted on high duty radial bearings enclosed in oil tight cases.

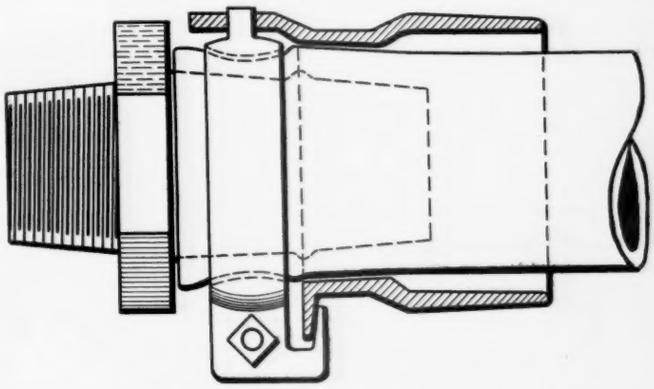
The spindle is made of high carbon hammered steel and the thrust is taken on high duty ball bearings. The spindle has a diameter of two inches at the driving end and three and one-quarter inches at the nose. It has a vertical feed of 16 in. and is equipped with a depth stop. Twelve changes of feed per revolution of the spindle are provided, ranging between .006 and .032 in.

The machine illustrated has a compound table which is provided with screw adjustments in all directions. Micrometer collars are provided on the in and out and the cross movements and it is not necessary to lock the table in position after an adjustment has been made. This table is 16 in. by 36 in. and the maximum distance from the end of the spindle to the top of the table is 25 in. The table has 16 in. vertical travel. A distance of 12¼ in. from the center of the spindle to the face of the column is provided.

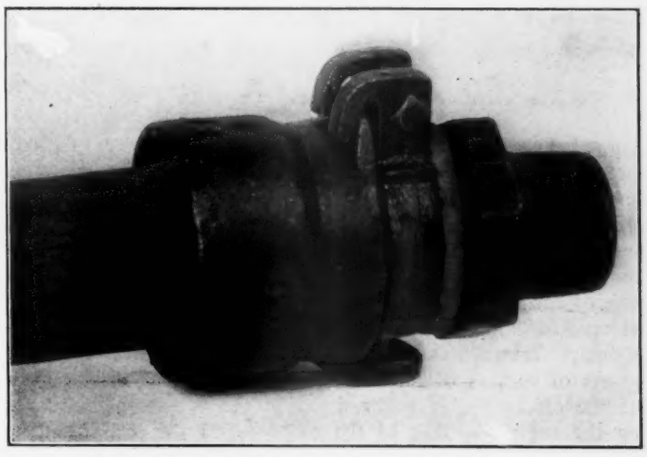
A belt drive from either a shaft or a motor can be used. In the latter case a 10 horsepower motor is specified. When shaft driven a 3-in. belt running on an 18-in. diameter pulley at 475 revolutions a minute is recommended in the specifications.

AIR HOSE PROTECTOR

The illustrations show a new design of air hose protector that is practically indestructible and may be applied easily to any air brake hose. It is designed to prevent the hose being cut at the nipple, and at the same time to not interfere with the flexibility of the hose, the protector being hinged to the clamp, as shown, for that specific purpose. The protector is made in a bell shape to increase the range of flexibility, and to also bring the protector away from the hose at the extreme end of the nipple, thereby preventing any possibility of cutting



Malleable Iron Protector for Air Hose



Peffers Air Hose Protector

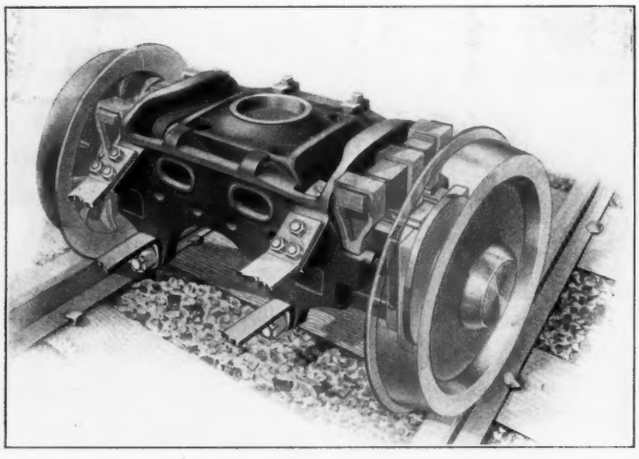
the hose. As will be noticed in the cross section the restricted portion of the protector terminates well above the end of the nipple so that any blow received by the protector will be transmitted to the hose above the end of the nipple.

Both the protector and the clamp are made of malleable iron. The protector is held in position by the clamp, which has a pin on one side and fingers on each side of the break in the clamp. The fingers extend underneath the lip on the protector, the lip being of such a width that when the clamp bolt is removed from the clamp the protector may be easily removed. It is claimed that the protector will last almost indefinitely, under fair usage, and that the clamp may be used over several times. This hose protector was invented by A. Roy Peffers, 474 South La Salle street, Aurora, Ill., who is also handling the general sales.

ECONOMY ENGINE TRUCK

An improvement in engine trucks, adaptable to either the two or four-wheel types, has been developed by the Economy Devices Corporation, 30 Church street, New York, and is shown in the accompanying illustrations. This employs a new type of centering arrangement, and also a new form for the truck frame and pedestal.

The development of this truck was brought about by the knowledge that the very large locomotives with wheel bases of about 34 ft. have so great a bolster displacement at the front truck that the usual designs are unsatisfactory both in guiding qualities and in preventing flange wear on the drivers. This is true because a bolster displacement of as much as 4½ in. is frequently required for this length of wheel base and the three

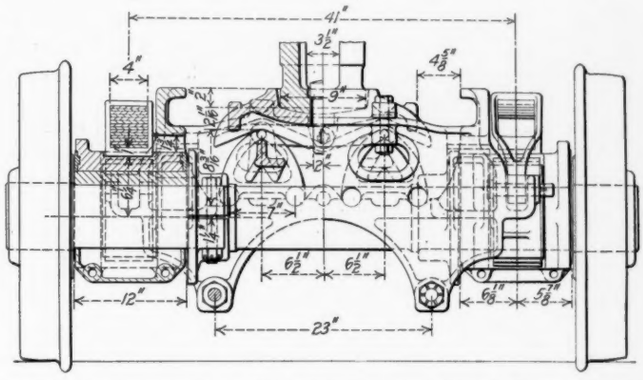


General View of the Economy Locomotive Front Truck

point hangers generally used must have an excessive length in proportion to the spread of the hanger pins, thereby reducing the initial resistance of the bolster, to the impairment of the guiding qualities. The evidence of this is seen in the greatly increased wear on the driving wheel flanges of these long locomotives. This form of truck is shown in the upper view of one of the illustrations and the design that has now been developed is shown below it. The latter is called a "constant resistance" centering arrangement and the bolster rests on the points of rockers of the form shown. Upon the displacement of the center pin in either direction the contact point moves on the curved surface of the rockers and the inclined plane to the bolster and thus maintains a practically constant ratio between X and Y, or a constant lateral resistance. It will be seen that this ratio in the three point hangers, shown above, increases very rapidly as the center pin is displaced laterally.

At the point of greatest displacement, which occurs when the locomotive is going around sharp curves or turnouts, especially on the light tracks usually found in engine terminals, the diminished resistance offered by this new type of support is particularly appreciated. Furthermore, the increased guiding effort on a truck on a tangent, or on curves found on the main line, which results from the larger ratio of X to Y that can be obtained in the central position, should have a striking effect in the form of diminished wear of driving wheel flanges.

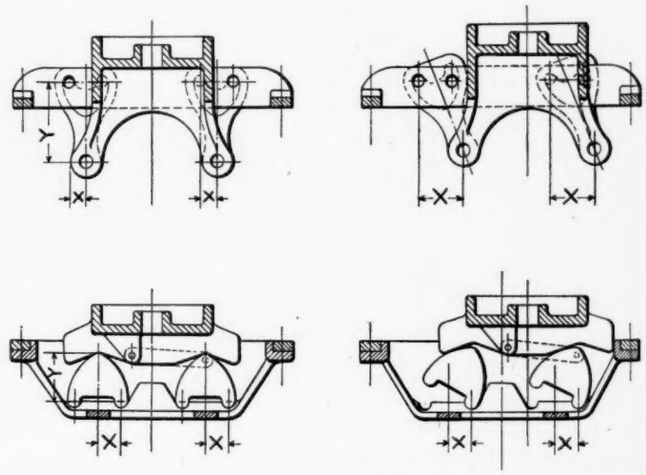
The frame and pedestals of the truck are cast in one piece and are so arranged that semi-elliptic springs of a good length



General Arrangement of the Economy Two-Wheel Engine Truck

can be used while still affording ample clearance under the locomotive frame. It will be noticed that the springs are supported by hangers directly from the main frame. Furthermore, advantage has been taken in this design to so locate the pedestal tie bars that they come inside the journal boxes, thus making provision for journal box cellars of a depth suitable to insure proper lubrication. The arrangement also facilitates the removal and replacement of cellars while packing.

The pedestals have been provided with pressed steel shoes of a special design, held in position by vertical flanges on the



The Upper Views Show the Usual Three Point Hangers, and the Lower the Economy Arrangement for Engine Trucks

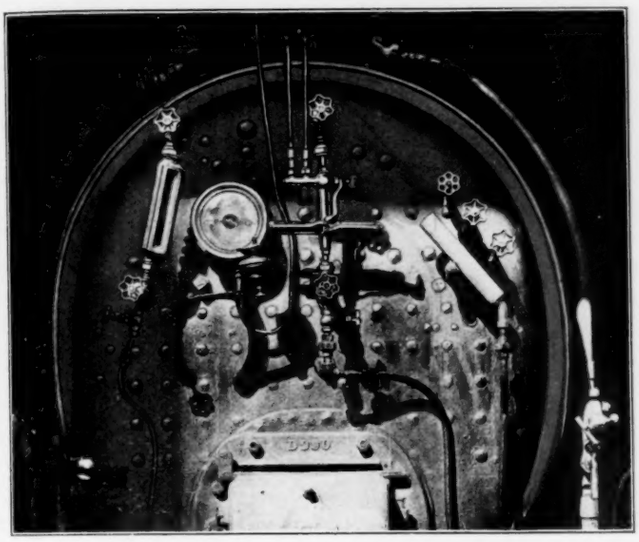
sides and with lips turned over the top and bottom. These can be quickly replaced when worn without dropping the wheels.

The design further includes cast iron axle collars secured to the axle inside of the journal boxes. These reduce hub wear and materially decrease the cost of maintenance.

SMALL ANTHRACITE SHIPMENTS IN JANUARY.—Shipments of anthracite coal during January, 1914, were 1,160,687 tons less than in January, 1913. The difference of over a million tons in production is due to the difference in the weather the first month of last year and this.

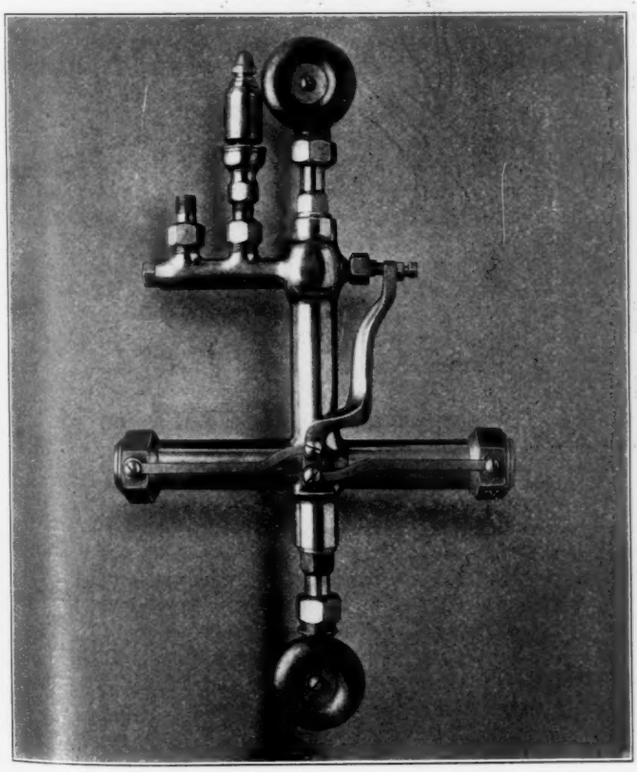
LOW WATER ALARM

A recently developed type of low water alarm for boilers is shown in the illustrations. This alarm is the invention of E. J. Shearer and W. D. Anderson, Lordsburg, New Mex., and is designed for use on either locomotive or stationary boilers.



Low Water Alarm in Position on a Boiler

The device has a small valve that opens ⅛ in. and allows the whistle to blow. The cross pipes at the bottom are the expansion pipes that operate the lever which connects with the valve.



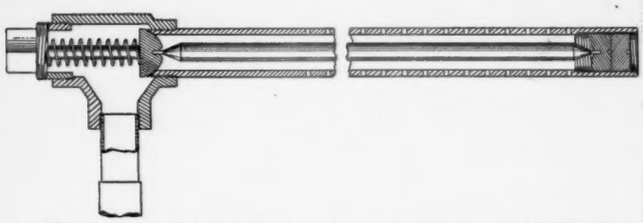
A Recently Developed Low Water Alarm

The alarm is placed on the boiler-head and set so that the cross pipes are the proper height from the bottom of the water glass. As the water becomes low in the boiler it also becomes low in the alarm. The steam follows the water, and as soon as the water leaves the cross pipes at the bottom of the alarm, the steam enters from the top cock and causes the expansion which operates the lever that opens the whistle valve.

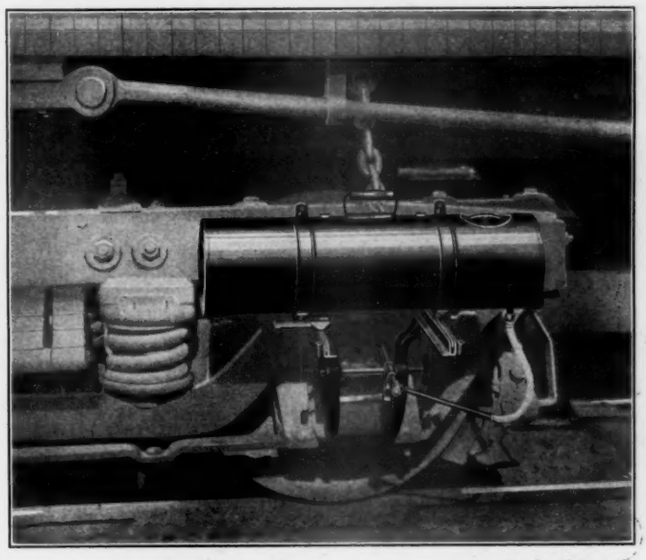
JOURNAL COOLER

The hot box is always considered one of the necessary evils of railroad operation, but it will be generally admitted that there is much possibility of improvement in the methods of cooling journal boxes.

The B-J cooler, which is shown in the illustrations, was designed to overcome train delay. The cooler consists of a tank resting on two supports which are clamped to the journal box. Water from the tank is carried to the hot journal through a short hose and pipe connection which is controlled by an automatic valve. When a journal becomes heated the tank is clamped to the box and the nozzle inserted on the rising side of the journal so that the water will tend to be carried up under the brass. This nozzle sprays the water as needed the full length of the hot journal, cooling it gradually. When the nozzle is placed in the hot journal box, the thermostatic element shown in the line engraving expands in the direction of its length, forcing back the feed valve and allowing free flow of the cooling agent to the spray pipe. This brings about a gradual uniform cooling of the journal and brass. With the cooling of the journal the thermostatic element gradually contracts, thereby reducing the flow until, when the box is at normal temperature the flow is practically stopped. It will thus be seen that the amount of water supplied to the journal is always proportionate to the degree to which the temperature of the journal is raised.



Thermostatic Valve Which Controls the Flow of the Water

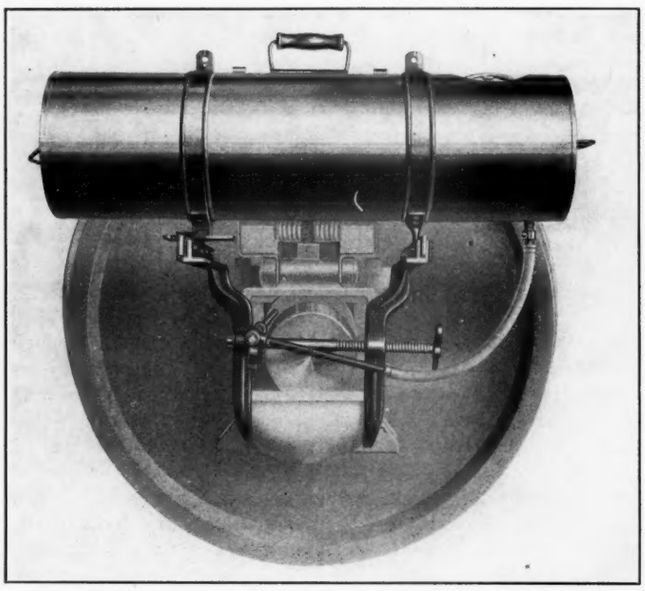


Cooler Applied to a Passenger Truck

No running time need be lost in applying the cooler as it can be attached during a regular stop of two minutes. By feeding the water only as it is required there is no occasion to

stop the train in order to replenish the tank. Typical of the possibilities in actual service, the following is taken from a railway report:

After running 46 miles to the first stop of the train, the journal box was found to be heating. At the second stop, 30 miles further on, the heat was increasing and at the next stop, 15 miles further, the oil was boiling and splashing. The cooler, containing seven gallons of water, was then applied. At the next stop, 41 miles further on, the box was shown to be cooling, while at the next stop, 22 miles further on, the box had been cooled to almost normal running temperature and the brass was



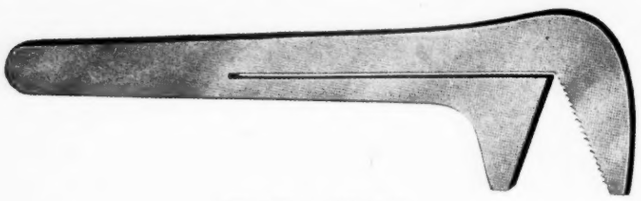
Method of Attaching the Cooler to a Journal Box

found to be in good condition. Five quarts of water was added to the cooler and the box was repacked. At the next stop, 77 miles further on, the box was found to be in good condition and there was little or no water passing through the thermostatic valve. The trip ended after another 60 miles, and the cooler was taken off, still containing a quantity of water which, when measured, showed that the journal had been cooled by using about three gallons.

This cooler is manufactured by the Transportation Utilities Company, 30 Church St., New York.

A NOVEL FORM OF WRENCH

The Shaw wrench is made in one piece, bevel-jawed, and is designed for any work than can be done by stillson, monkey, alligator, or flat wrenches, and many classes of work for which special tools must be employed. As will be seen from the illustration, the novel feature of this wrench is the spring, because of which, it is claimed, it will grip a steel rod or a round head bolt instantly, and cannot slip while in use. It requires no adjustment. The wrench is manufactured by the Shaw Propellor Company, Board of Trade building, Boston, Mass.



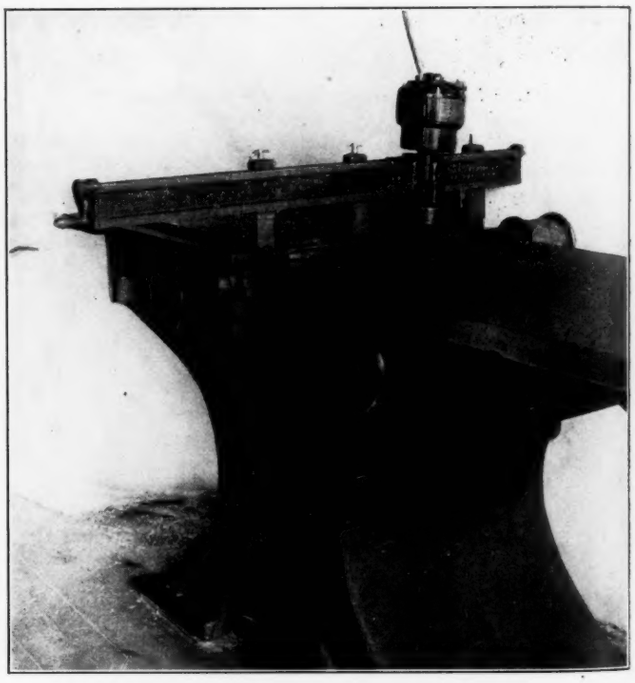
The Shaw Wrench

PORTABLE GRINDER FOR PLANERS

The need for a device that will accurately grind the knives of planers and jointers without taking them from the tool has been recognized by users of wood-working machinery. Removing the knives and putting them back properly adjusted is a somewhat difficult task. It is often done hurriedly and improperly, resulting not only in poor work, but inefficient production. This is especially true of the thin, hard knives used on modern cylindrical head planers.

A portable grinder has recently been perfected by the Stockbridge Machine Company, Worcester, Mass., which meets this demand. This machine is electrically driven, will grind true, is adaptable to all makes and sizes of planers, is easily attached and is light enough to be easily carried from one machine to another.

As will be seen in the illustration, the motor is mounted in the grinder head. Current is taken from an ordinary lamp socket. To the saddle is attached a split nut engaging the feed screw which lies along the top of the bridge. The saddle can be fed the length of the bridge in either direction and at any speed desired. The bridge is supported at the ends, or any point most convenient, by two angular brackets which are bolted to the machine bed, holding the grinder rigid. The grinding wheel, which is cup-faced, can be raised or lowered by a thumb-



Portable Electric Grinder in Operation

screw and can be set to grind the required amount from the knives, automatically feeding itself to a positive stop. In the grinding wheel there is a tension spring which maintains a constant and uniform pressure on the wheel, thus eliminating all danger of overheating and burning the knives.

The grinder head is pivoted at the center and can be tilted to either side of the perpendicular, and is held in place against a stop giving the same angle on either side. The tilted head gives a concaved cutting edge to the knives. A positive stop holds each knife in exactly the same relative position to the wheel.

Third Class Sleeping Cars.—The advisability of the adoption of third class sleepers has recently come up in Germany. Experiments with such cars have already been made in Norway and Sweden.

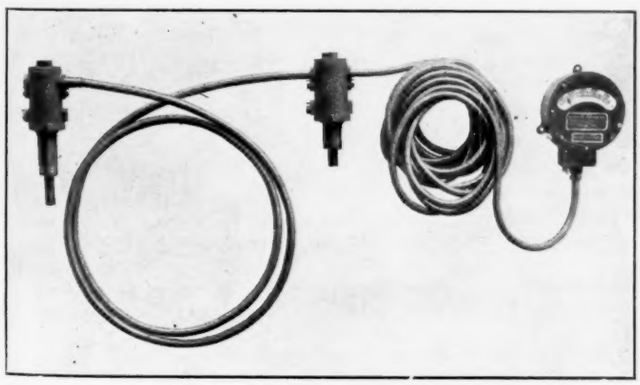
PYROMETER FOR SUPERHEATER LOCOMOTIVES

While it is true that remarkable economy results from the operation of locomotives equipped with superheaters, even when the best practices are not followed in handling them, the highest economy is obtained when the engines are given proper attention at the terminals and are carefully handled on the road. Whether the engines are receiving the care that they should at the roundhouses and are being efficiently operated on the road is best determined by the amount of superheat produced.

Recognizing the need of an indicator whereby the engineer could, at all times, be informed as to the temperature of the steam in the steam chest, attempts were made to find a suitable pyrometer for this purpose. Several instruments of both the pressure and electrical types were tested and found to be unsuited to the severe conditions under which they would have to operate. In order to get a satisfactory instrument for this purpose it was necessary to develop one that would meet the requirements established by the service in which it must operate. The conditions to be met were those of excessive vibration, varying temperatures and atmospheric conditions, as well as the rough handling to which devices on locomotives are subject. To meet these conditions required delicacy of adjustment and freedom of operation, combined with increased sizes of parts and durability of construction.

An instrument which has been developed to a satisfactory state is manufactured for the Locomotive Superheater Company, 30 Church street, New York, and is of the electrical type, consisting of thermo couples, constructed and arranged in accordance with the Bristol system. The cold end is located in the boiler, in the saturated steam, and the hot end in the steam chest, directly in the flow of the superheated steam. Electrical connections are established to an indicator of the milli-voltmeter type, located on the gage bracket in the cab.

The ends of the couples are so located that a variation of the outside temperature has practically no effect upon them. The

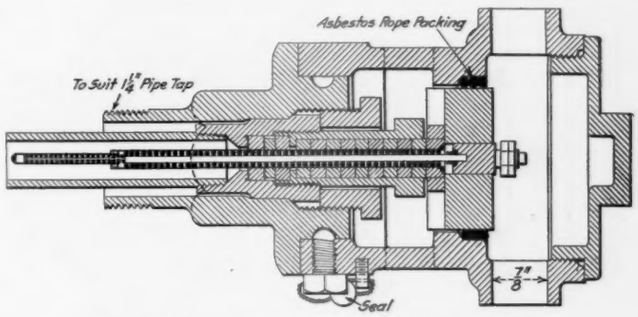


Assembled Parts of the Pyrometer Apparatus

cold end of the couple, placed in the boiler in the saturated steam, is subject to only the slight variation in temperature due to the variation of the steam pressure, which does not vary more than a few pounds when the locomotive is in operation. The hot end of the couple, placed in the steam chest in the flow of superheated steam, is subjected to a range of temperatures from that of saturated steam to about 650 deg. The difference in electromotive force generated by the hot and cold ends of the couples is read directly in degrees Fahrenheit on the dial in the cab.

The electrical lead and extension between the couples and the instrument are designed to provide flexibility and the least amount of deterioration resulting from handling and bending. They are insulated with a specially prepared composition, which is affected by neither moisture nor temperature, and they are finally enclosed within a flexible bronze armor which prevents them from being bruised by substances falling on them.

The instrument itself is of the milli-voltmeter, double-jeweled Weston type, the movement having been very carefully designed from a standpoint of accuracy and lightness, in order that it may be depended upon to register accurately the extremely low electromotive force generated by the thermo couples. At the same time its construction is substantial enough to withstand the vibration and the temperature conditions to which it is subjected. The dial of the instrument is graduated to read directly in degrees Fahrenheit, and has a range of from 250 deg. to 750 deg. The pointer and graduations are carefully selected with



Section Through the Saturated Steam Fixture

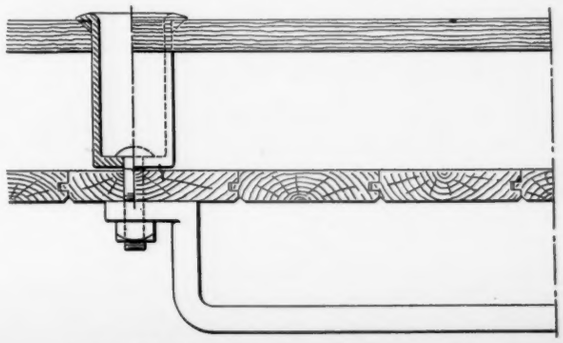
the purpose in view of making them distinctly visible at all times, under the light conditions that prevail in a locomotive cab.

When a superheater locomotive is standing or drifting with the throttle closed, there is, of course, no superheat being obtained, and the indicating hand of the pyrometer instrument in the cab will be at the left hand side of the dial, reading between 350 and 390 deg., assuming that the boiler pressure carried is 200 lb. or less. As the throttle is opened and the engine starts to work, steam from the boiler passes through the superheater pipes and the superheating process begins. As the engine starts, the pointer will move from left to right on the scale, showing an increased temperature in the steam chest and as the engine is worked harder the superheat added to the steam increases until, under average conditions, the indicator registers between 600 and 650 deg.

When the pyrometer operates in this manner, it is an indication to the engineman that the locomotive is being handled so that the maximum saving that the superheater makes available is being obtained. If it fails to operate in this manner, it shows him that either the locomotive is not being operated to produce the best results or that it has not received the proper attention at the roundhouse.

SOCKET WASHER FOR GRAB IRONS

In applying ladders or grab irons to cars, it is often necessary to place a block or cripple between the siding and the lining in order to allow the bolt to be drawn up tight and



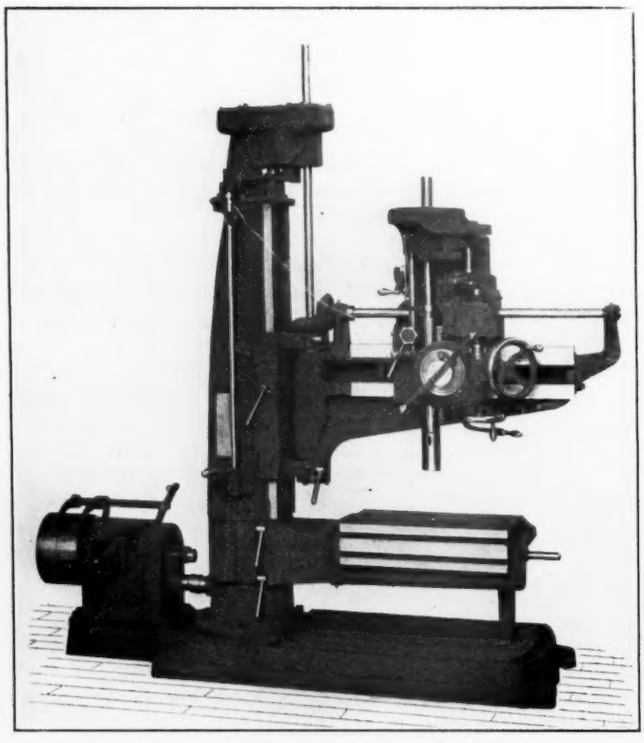
Socket Washer Used in Applying a Grab Iron

make the ladder or grab iron secure. In many cases where grab irons are applied to existing cars, it is necessary to remove either the siding or the lining, apply a block, and then apply new siding or lining in place of that removed. In order to facilitate and cheapen the application of grab irons and ladders, there has been developed by the Wine Railway Appliance Company, Toledo, Ohio, a socket washer which, it is claimed, is easily applied and makes the grab iron or ladder much more secure than the use of a block. By making the washer about ⅛ in. short, as there is only ¾ in. thickness of wood to shrink and wear, the device when properly applied should remain firm and tight indefinitely. The washer can be designed in such a manner that the bolt may be removed and replaced from the outside of the car.

HEAVY DUTY RADIAL DRILL

The Fosdick Machine Tool Company, Cincinnati, Ohio, has recently perfected a new design of 3 ft. heavy duty box column radial drill, which is shown in the accompanying illustration. This machine, with the exception of the column, arm, and table, is the same design as the round column machine, built by the same company, which was fully illustrated and described on page 619 of the November, 1913, issue of this journal.

Adaptability to a large variation in the range of work it is capable of performing, is the special feature of this new machine. Correct feeds and speeds are available for all sizes of



Three-Foot Box Column Radial Drill

drills from a 5/16 in. carbon steel drill to a 3 in. diameter high speed steel drill. A complete list of the proper speeds and feeds for different drilling conditions are given on a metal plate conveniently attached to the column of the machine.

For heavy drilling or tapping in steel, an oil channel has been cast around the base, which drains to a large reservoir under the column, where a pump and piping may be attached. For the smaller drilling and tapping operations a liberal channel has been provided around the table, which drains to one corner, under which any receptacle for the lubricant may be placed, thus avoiding the use of a pump and return piping.

Special attention has been given to the design of the column and the arm. The former is a heavy, one piece box section, internally ribbed, and the latter is of the pipe and beam section, which has proved to be a very rigid combination for this work. The construction permits a long saddle bearing to be securely gibbed to the wide flat space of the column, making sagging of the arm impossible, and provides a means for taking up any amount of wear, as well as bringing the binding levers close to the operator.

The arm rests on a special ball bearing which reduces the effort required to swing from one position to another and allows rapid setting. The elevating screw, which raises and lowers the arm by power, is suspended on a ball bearing and the handle is placed in a convenient position. Safety trips for both extremes are provided. A maximum distance from the base to the end of the spindle of 52½ in., and minimum distance of 16 in., is allowed.

There are five changes of feed provided in the head, all made with a single lever and without stopping the machine. These give speeds from .007 to .031 in. per revolution.

The speed box gives six changes of speed all made by a single lever. The back gears are on the head and give three changes without stopping the machine. There are thus 18 different speeds of the spindle, ranging between 25 and 400 r. p. m., that can be used. A positive overtake keeps the machine running at a reduced speed and avoids shock when making changes. The spindle has a traverse of 12 in., and the head has a traverse on the arm for a distance of 23¼ in. The maximum distance from the spindle to the column at the base is 39 in.

All gears throughout the machine are enclosed, but provision is made for easy accessibility in case it is required. The bearings are made of a special phosphor bronze.

The tapping reverse functions are very simple and powerful and adjustable from the outside for any amount of wear. The lubrication system is complete and nearly all of the gears run in oil. The machine has a net weight of 4,200 lb.

ADJUSTABLE SPACING COLLAR

A collar designed primarily for use in milling machine manufacturing operations where two or more milling cutters on the same arbor must be spaced an exact distance apart, is shown in the accompanying illustration. When it is necessary to grind the side of the teeth of milling cutters, the distance between the faces is changed, and in order to maintain the proper width on the piece being machined, compensation must be made in some way for the amount ground from the cutter. This is sometimes accomplished by carrying in stock an assorted lot of solid spacing collars of varying lengths, and if the exact size cannot be found, provision must be made for grinding off a solid collar that is too long or shimming up one that is too short.

An Adjustable Spacing Collar for Milling Cutters

The collar illustrated, which is sold by Scully-Jones & Co., Railway Exchange, Chicago, is so designed that the thickness can be changed to a total of .024 in. This total is divided into twelve spaces of .002 in. each. The adjustment is quickly made and after each adjustment it is, in effect, a solid collar.

Reference to the illustration will show the construction which permits this varying of lengths. In addition to its use as a spacing for milling cutters it can also be used for other purposes where solidity and adjustability are desired.

NEWS DEPARTMENT

The New York Central has recently completed an all-steel dining car at the West Albany shops, and four more cars of the same type are now under construction there.

R. C. Richards, chairman of the central safety committee of the Chicago & North Western, has been appointed chairman of a committee of the City Club of Chicago that proposes to conduct a campaign against trespassing on railway property.

The "safety first" movement is to be introduced on the Canadian Government Railways. F. P. Gutelius, general manager, Moncton, announces the appointment of J. E. Long, safety engineer, as the head of the department. He is to organize committees and hold meetings.

Professors from the Pennsylvania State College are to give lectures to the apprentices in the shops of the Pennsylvania Railroad at Altoona. Lectures will be given twice a week to members of the fourth year class. Apprentices will have the option of joining the lecture class or not; but having once joined, attendance will be compulsory.

Southbound passenger train No. 1 of the Queen & Crescent was stopped by robbers near Attalla, Ala., on the night of February 19, and all of the registered mail was taken from the mail car. One postal clerk who resisted the robbers was stabbed. The mail and express cars were detached from the train and run a considerable distance forward; and the passengers were not molested.

Dennis McGuire, a locomotive engineman on the Lehigh Valley, has been granted a month's vacation with pay and an honor button for having brought forward a new safety-first idea. He suggested to Superintendent Charles Shea that engine inspectors be equipped with magnifying glasses, so that they might more readily detect cracks and flaws on axles and other mechanism. The suggestion was at once adopted and McGuire received his reward.

In 1910, the Southern Pacific, Pacific system, handled about six and a half million pieces of baggage; in 1911, it handled six and a quarter million; and in 1912, it handled almost seven and a quarter million. For the three years, the total was 19,831,248. Out of this number, only 180 pieces went astray—an average of 60 pieces a year. And in many cases, baggage would not have gone astray had passengers themselves checked their belongings, had them rechecked, when necessary, or changed the checking when they changed their own destination en route.

The Pennsylvania Railroad has now on its pension rolls 4,037 employees, of whom 27 are women. During the past 13 years the total number of employees placed on the pension rolls has been 7,800. The payments have aggregated $9,500,500. This includes the lines both east and west of Pittsburgh. The company has issued a circular in which there is a large picture taken at a recent luncheon given to the veterans of the road by the Railroad Young Men's Christian Association of West Philadelphia. At this luncheon there were present 150 retired employees, of whom 48 had been in the service of the company for 48 years or more, and of whom 89 had served in the army during the Civil War.

The army of Pennsylvania Railroad Company employees in the Altoona district, numbering approximately 21,000, with the dependent members of their families, will herald with delight the news that the Pennsylvania Railroad will issue passes in the same manner as in 1913. The thousands of workmen and members of their families have been awaiting the action of the road on the pass question since the Pennsylvania State Public Service Commission issued its edict that the granting of passes to employees and dependent members of their families by the company would not be considered as a violation of the law. General Manager S. C. Long has issued a notice to the effect that the Public Service Commission's ruling will be accepted as affording protection against exaction of penalties for the issuance of passes to dependent members of the families of officers and employees, and the notice of November 29 announcing discontinuance of passes is annulled.—*Altoona Tribune.*

A CORRECTION

The name of the publishers of the book on Working Drawings of Machinery, noticed in the February issue, page 60, was given incorrectly. It should have been John Wiley & Sons, Inc., 432 Fourth avenue, New York.

A LESSON IN CIPHERS

The Baltimore & Ohio has 2,000 offices, and the stationer, in a circular enjoining economy, says that stationery and printing cost the road in 1913 about $500,000. The offices used in that year 700,000 lead pencils, 1,000,000 pens, 23,000,000 pins, 18,000,000 envelopes, 14,000,000 sheets of carbon paper, 23,000,000 second sheets, 11,000,000 rubber bands, 570,000 blotters, 2,500,000 letter fasteners, 2,000,000 file backs, 10,000 sponges, 3,300 rules and other office articles in proportion. These supplies cost $60,000.

COLD WEATHER INSTRUCTIONS

The Chicago & North Western has issued a bulletin to trainmen and others concerned giving instructions to be observed during cold weather. These include the following:

"Train and enginemen will bear in mind that in all cases speed must be sacrificed for safety. You will not be criticized for a failure to make time or for losing time under bad weather conditions. Bear in mind the great importance of proper observance of signals and proper flagging protection at all times and see that the rules in this respect are obeyed.

"Enginemen will be particular to use good judgment and run carefully, evenly, and safely during fogs, snow storms or stormy weather. Be particularly alert and careful at turn around subpoints and coal and water points. Observe speed restrictions and slow orders, and do not exceed scheduled time during extreme cold weather."

ADVANCED COURSE IN ENGINEERING AT COLUMBIA UNIVERSITY

The trustees of Columbia University, New York, have recently determined to raise the requirements of admission to the schools of mines, of engineering and of chemistry and generally to elevate and strengthen the course in engineering and technical studies from and after July 1, 1914. These schools will then become advanced graduate schools to which students of any branch of engineering, who have had a suitable preliminary training at a scientific school or college, may come for the highest type of professional instruction and for training in methods of research. After July 1, 1915, the candidates for admission to these schools will be required to present evidence of such preliminary, general education as can ordinarily be had only by taking at least three years of study in a college or scientific school of high rank. This will place the schools of mines, engineering and chemistry on the same academic plane

as the present schools of law and medicine in Columbia University.

B. & O. VETERANS

Employees of the Baltimore & Ohio who have been twenty years or more in the service, are organizing a Veteran Employees' Association, with social and fraternal features. There is to be a branch on each division. Branches have been established in Philadelphia with 369 members, and in Baltimore with 279 members. Other branches will be organized in the near future at Brunswick, Md., with 180 members; Cumberland, Md., 100; Newark, Ohio, 100; Pittsburgh, 400; Grafton, W. Va., 100; Wheeling, W. Va., 75; Chicago Junction, Ohio, 125, and Garrett, Ind., 60. After these branches have been organized, the association will be extended to the Baltimore & Ohio Southwestern, the Cincinnati, Hamilton & Dayton and the Staten Island lines. One of the objects of the association is to lend assistance to the families of the members, should help be required, in event of death. The education of deceased members' children will be provided for and such other assistance as comes within the province of the association will be rendered. Membership is voluntary and the dues have been made nominal.

STANDARD TIME BY WIRELESS TELEGRAPH

The United States Naval Radio station at Arlington, opposite Washington (post office, Radio, Va.), sends out standard seventy-fifth meridian time every day, at noon and at 10 p. m.; and the same plan, with slight variations, is carried out at other stations—Key West, New Orleans, North Head, Eureka, San Diego and Mare Island. These time signals are sent primarily for the benefit of ships at sea, but we are informed that a number of jewelers in the eastern and the middle western states are making use of the signals. At this season of the year the time signals sent out from Arlington are received at stations on the Pacific coast. The Arlington station has a direct wire from the naval observatory, across the Potomac river, from which the signals are repeated by a relay which actuates the radio sending instrument. The time signals sent out from the stations on the Pacific coast come from the observatory at the Mare Island navy yard. The signals are sent in the same way that they are sent over telegraph wires, but they are kept up for five minutes, with the customary intermissions, beginning five minutes before the even hour. A small and simple radio installation is adequate to receive these signals.

MEETINGS AND CONVENTIONS

Railway Storekeepers' Association.—It has been decided by the executive committee that the eleventh annual convention of the association will be held at the Hotel Raleigh, Washington, D. C., May 18, 19 and 20, 1914.

The American Railway Tool Foremen's Association.—The American Railway Tool Foremen's Association will hold its sixth annual convention at the Hotel Sherman, Chicago, July 20-22, 1914. Among the subjects to be considered at the meetings are: The Standardization of Reamers for Locomotive Repair Shops; Machine Tool Repairs; Tool Room Grinding; Special Tools for Drilling; Reaming and Milling; Distribution of Tools for Shop Use; Dies for Cold Work, and Press and Special Punching.

Western Railway Club.—At the February meeting of the Western Railway Club a paper was presented on the Development of Milling Machines, by A. J. Baker, sales engineer for the Marshall & Huschart Machinery Company, Chicago. Mr. Baker spoke of the increasing use of milling machines in railway shops, and spoke of the marked improvement in milling machines during the past five years. Five years ago the maximum metal that could be removed by this machine per minute was 12 cu. in. of machine steel on a No. 5 Meehan-Cullom type, whereas today a machine of the same dimensions and cost will remove about 37½ cu. in. He went into the design of milling cutters at some length, clearly bringing out the importance of grinding these cutters properly.

Railway Business Association.—The Railway Business Association, a part of whose General Executive Committee are elected and a part appointed, has organized for 1914 with the following official roster: President, Geo. A. Post, New York; treasurer, Chas. A. Moore, New York; assistant treasurer, M. S. Clayton, New York; vice-presidents—A. M. Kittredge, Dayton, O.; W. E. Clow, Chicago; G. W. Simmons, St. Louis; S. P. Bush, Columbus, O.; Alba B. Johnson, Philadelphia; H. G. Prout, Pittsburgh; W. G. Pearce, New York. Executive Members—G. M. Basford, New York; J. C. Bradley, Buffalo; J. S. Coffin, New York; Walter H. Cottingham, Cleveland; O. H. Cutler, New York; Henry Elliot, East St. Louis; Irving T. Hartz, Chicago; F. T. Heffelfinger, Minneapolis; Robert P. Lamont, Chicago; W. B. Leach, Boston, Mass.; E. B. Leigh, Chicago; W. H. Marshall, New York; William McConway, Pittsburgh; A. H. Mulliken, Chicago; Rudolph Ortmann, Chicago; S. F. Pryor, St. Louis; W. W. Salmon, Rochester, N. Y.; Justus H. Schwacke, Philadelphia; Geo. T. Smith, Jersey City; James S. Stevenson, Detroit; H. H. Westinghouse, New York; W. W. Willits, Chicago.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 5-8, 1914, Detroit, Mich.

AMERICAN RAILWAY MASTER MECHANICS' ASSOC.—J. W. Taylor, Karpen building, Chicago. Convention, June 15-17, 1914, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—A. R. Davis, Central of Georgia, Macon, Ga. Convention, July 20-22, 1914, Hotel Sherman, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—S. Skidmor' 946 Richmond street, Cincinnati, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, 922 McCormick building, Chicago. Convention, May 18-22, 1914, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 829 W. Broadway, Winona, Minn. Convention, July 14-17, 1914, Hotel Sherman, Chicago.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 18-20, 1914, Milwaukee, Wis.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention, May 25-28, 1914, Philadelphia, Pa.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen building, Chicago. Convention, June 10-12, 1914, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC. OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 8-11, 1914, Nashville, Tenn.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 18-20, 1914, Hotel Raleigh, Washington, D. C.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. & H. R., East Buffalo, N. Y. Convention, August, 1914, Chicago, Ill.

RAILROAD CLUB MEETINGS

Club.	Next Meeting.	Title of Paper.	Author.	Secretary.	Address.
Canadian	Mar. 10	Car Service	J. E. Duval.....	Jas. Powell.....	Room 13, Windsor Hotel, Montreal.
Central	Mar. 12	Rules of Interchange and Banquet.....	W. H. Sitterly.....	Harry D. Vought.	95 Liberty St., New York.
New England....	Mar. 10	Rules of Interchange and Annual Meeting	.....	W. E. Cade, Jr..	683 Atlantic Ave., Boston.
New York.....	Mar. 20	Annual Electrical Night.....	E. Huber Stokar....	Harry D. Vought.	95 Liberty St., New York.
Richmond	Mar. 9	Electric Light and Power.....	H. R. Palmer.....	F. O. Robinson..	C. & O. Ry., Richmond, Va.
St. Louis.....	Mar. 13	Past and Present Railroading.....	O. F. Bary.....	B. W. Frauenthal.	Union Station, St. Louis, Mo.
Southern & S'w'rn	Mar. 19	Thermit Welding	.....	A. J. Merrill.....	218 Grant Bldg., Atlanta, Ga.
Western	Mar. 17	Tests of Chilled Cast Iron Wheels.....	Prof. L. E. Endsley.	Jos. W. Taylor...	1112 Karpen Bldg., Chicago.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

C. A. BINGAMAN has been appointed assistant engineer of motive power of the Philadelphia & Reading, with headquarters at Reading, Pa.

W. M. BOSWORTH has been appointed mechanical engineer of the Louisville & Nashville, with office at Louisville, Ky.

C. C. ELMES has been appointed assistant engineer of motive power of the Philadelphia & Reading, with headquarters at Reading, Pa.

E. B. HALL, whose appointment as assistant to the general superintendent of motive power and car departments of the Chicago & North Western, with headquarters at Chicago, was announced in the February issue, began railway work in July, 1889, with the Chicago & North Western, and has remained in the service of that road. Until August, 1892, he was machinist helper at Hawarden, Iowa, and then for six years was a fireman on the Northern Iowa and Western Iowa divisions. From October, 1898, to September, 1907, he was a locomotive engineer on the Sioux City division, and on the latter date was advanced to road foreman of engines of that division. He was master mechanic of the Northern Iowa and Sioux City divisions at Eagle Grove, Iowa, from March, 1910, to May, 1912, when he was transferred to the Wisconsin division in a similar capacity, with headquarters at Chicago, which position he held at the time of his recent promotion.

A. P. PRENDERGAST, formerly superintendent of motive power of the Baltimore & Ohio, at Baltimore, Md., has been appointed superintendent of machinery of the Texas & Pacific, with headquarters at Marshall, Tex., succeeding F. S. Anthony, resigned. After graduating from the public schools in West Virginia, Mr. Prendergast took up the study of special technical subjects. He entered the service of the Baltimore & Ohio in the mechanical department in 1893 as an apprentice, and after completing his apprenticeship he served as a machinist, and subsequently was made foreman. He was then promoted to master mechanic at Grafton, W. Va., and later was transferred in the same capacity to the Riverside shops at Baltimore, Md., becoming master mechanic at the Mt. Clare shops, Baltimore, on January 1, 1910. The following November he was made superintendent of motive power of the Baltimore & Ohio Southwestern at Cincinnati, Ohio, and in May, 1912, his authority was extended over the Cincinnati, Hamilton & Dayton. In January, 1913, he was appointed superintendent of motive power of the Baltimore & Ohio proper, with headquarters at Baltimore, Md., from which position he resigned on December 31, 1913.

A. P. Prendergast

T. W. HEINTZELMAN, superintendent of motive power of the Southern Pacific at Sacramento, Cal., has been appointed general superintendent of motive power, with headquarters at San Francisco, Cal., succeeding H. J. Small, retired.

D. J. MULLEN has been appointed assistant to the superintendent of motive power of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Indianapolis, Ind.

H. OSBORNE has been appointed assistant mechanical superintendent of the Canadian Pacific, with headquarters at Montreal, Que.

H. J. SMALL has retired as general superintendent of motive power and machinery of the Southern Pacific. Mr. Small has been in railway service since 1868, when he commenced as a machinist for the Chicago & North Western at Chicago. He was from 1869 to 1874 successively draftsman for the Kansas Pacific, the Northern Pacific and the Toledo, Wabash & Western. The succeeding three years he was general foreman of the International & Great Northern, and from 1877 to 1879 was master mechanic of the Galveston, Houston & Henderson. He was then for two years master mechanic of the Texas & Pacific, returning to the Northern Pacific in 1881 as assistant superintendent of machinery, where he remained until 1886. From 1887 to 1888 Mr. Small was assistant superintendent of motive power of the Philadelphia & Reading, and he then went to the Southern Pacific as superintendent of motive power and machinery. On July 1, 1902, he was made general superintendent of motive power and machinery, with headquarters at San Francisco, Cal., from which position he now retires.

F. O. WALSH has been appointed superintendent of motive power and equipment of the Georgia Railroad, with headquarters at Augusta, Ga.

W. E. WOODHOUSE, assistant superintendent of motive power of the western lines of the Canadian Pacific, has been appointed superintendent of motive power of the eastern lines, with headquarters at Montreal, Que.

T. W. YOUNGER has been appointed superintendent of motive power of the northern district of the Southern Pacific, with headquarters at Sacramento, Cal., succeeding T. W. Heintzelman, promoted.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

WILLIAM APTED has been appointed road foreman of engines of the Michigan Central at Detroit, Mich., succeeding W. R. Walsh.

W. S. BUTLER, master mechanic of the Chesapeake & Ohio at Hinton, W. Va., has been appointed master mechanic of the Huntington and Big Sandy divisions, with headquarters at Huntington.

J. J. CAREY has been appointed master mechanic of the Cincinnati, Hamilton & Dayton at Ivorydale, Ohio, succeeding C. A. Gill.

D. C. CLOUGH has been appointed master mechanic of the Oregon Electric and the United Railways, with office at Portland, Ore., succeeding G. H. Hopkins, resigned

W. H. DAVIES has been appointed road foreman of engines of the Chicago & Alton, with headquarters at Bloomington, Ill.

JOHN DICKSON has been appointed general master mechanic of the Spokane, Portland & Seattle, the Oregon Trunk, Oregon Electric and United Railways, with headquarters at Portland, Ore. Mr. Dickson began railway work as machinist apprentice with the Great Northern. He was subsequently until 1899 machinist, air brake man and draftsman, leaving that road to become instructor in the Mechanic Arts High School at St. Paul, Minn. He remained in that position for two years, returning to the Great Northern as general air brake instructor, and was successively superintendent of shops at Everett, Wash., and

master mechanic of the Dakota division. He has been with the Spokane, Portland & Seattle as master mechanic since it was first put in operation, and on February 1 was made general master mechanic, as above noted.

J. G. DOLE, whose appointment as master mechanic of the Alliance division of the Chicago, Burlington & Quincy, with headquarters at Alliance, Neb., was announced in the February issue, was born November 7, 1880, at Mohicanville, Ohio, and received a high school education. He began railway work in October, 1897, with the Chicago, Burlington & Quincy as machinist apprentice, and from 1902 to 1906 was successively machinist for the Northern Pacific and the Chicago & North Western. The following two years he was employed by the Missouri Pacific as division foreman at Coffeyville, Kan., general foreman at Osawatomie, Kan., and as division foreman at Wichita, Kan. He then returned to the Burlington in 1908 as general foreman at Denver, Colo., and later was transferred to Lincoln, Neb., in a similar capacity, holding this position until January 16, when he was promoted to division master mechanic at Alliance, Neb., as above noted.

W. J. EDDY has been appointed master mechanic of the Louisiana division of the Rock Island Lines at El Dorado, Ark., succeeding R. C. Hyde, promoted.

W. A. HALL has been appointed master mechanic of the International & Great Northern at Mart, Tex., succeeding T. H. Williams.

W. P. HOBSON, master mechanic of the Cincinnati division of the Chesapeake & Ohio, has had his jurisdiction extended over the Ashland division, with headquarters at Covington, Ky.

C. M. HUFFMAN has been appointed master mechanic of the San Pedro, Los Angeles & Salt Lake at Milford, Utah, succeeding J. M. Gailey.

R. C. HYDE has been appointed master mechanic of the Minnesota division of the Rock Island Lines at Manly, Iowa, succeeding F. W. Williams, resigned.

A. J. KLUMB has been appointed assistant master mechanic of the Chicago, Milwaukee & St. Paul at Milwaukee, Wis., succeeding C. Lundburg.

F. R. PENNYFATHER, district master mechanic of the Canadian Pacific at Cranbrook, B. C., has been appointed master mechanic of the Manitoba division, with headquarters at Winnipeg, Man.

G. W. ROBERTSON, master mechanic of the Ashland division of the Chesapeake & Ohio at Lexington, Ky., has been appointed master mechanic of the Hinton division, with headquarters at Hinton, W. Va.

A. ROESCH has been appointed master mechanic of the Colorado & Southern at Trinidad, Colo., succeeding J. M. Davis.

W. E. STOERMER has been appointed road foreman of engines of the Southern Pacific at Los Angeles, Cal., succeeding C. H. Holdredge.

F. E. WOLFE has been appointed road foreman of engines of the Pere Marquette at Grand Rapids, Mich.

CAR DEPARTMENT

H. H. GERBACH has been appointed car foreman of the Great Northern at Great Falls, Mont., succeeding C. J. Grant.

T. E. HESSENBRUCH has been appointed assistant general car inspector of the Philadelphia & Reading, with headquarters at Reading, Pa.

R. B. RASBRIDGE has been appointed superintendent of the car department of the Philadelphia & Reading, with headquarters at Reading, Pa.

CHARLES RAY has been appointed car foreman of the Chicago, Milwaukee & St. Paul at Tacoma, Wash., succeeding E. S. Hartow.

W. SNELL has been appointed general foreman of the car department of the Chicago, Milwaukee & St. Paul, at Minneapolis, Minn., succeeding W. A. Parker.

R. D. WILSON has been appointed general car inspector of the Philadelphia & Reading at Reading, Pa., succeeding R. B. Rasbridge, promoted.

SHOP AND ENGINE HOUSE

WILLIAM BELYEA has been appointed general foreman of the Pere Marquette at Benton Harbor, Mich.

GEORGE C. BINGHAM has been appointed general foreman of the Chicago & North Western at Huron, S. D., succeeding F. W. Anderson.

R. L. BLACK has been appointed general foreman of the Norfolk & Western at Columbus, Ohio.

T. L. BROWN has been appointed general foreman of the Norfolk & Western at Kenova, W. Va.

D. W. DAY has been appointed locomotive foreman of the Grand Trunk Pacific at Jasper, B. C., succeeding F. Lozo, transferred.

R. DENNIS has been appointed general foreman of the Toledo & Ohio Central at Columbus, Ohio, succeeding G. P. Young.

B. FERRIS has been appointed acting general foreman of the Detroit, Toledo & Ironton at Delray, Mich.

P. J. FLYNN has been appointed general foreman of the Delaware, Lackawanna & Western at Syracuse, N. Y., succeeding B. F. Roosa.

F. Lozo has been appointed locomotive foreman of the Grand Trunk Pacific at McBride, B. C., succeeding A. H. Mahan, transferred.

A. H. MAHAN has been appointed locomotive foreman of the Grand Trunk Pacific at Prince George, B. C.

N. W. NORSWORTHY has been appointed general foreman of the Norfolk & Western at Crewe, Va.

GEORGE SCHIMMING has been appointed shop foreman of the Chicago & North Western at Madison, Wis., succeeding J. F. Cosgrove.

PURCHASING AND STOREKEEPING

SAMUEL F. CLARK has been appointed purchasing agent and general storekeeper of the Spokane, Portland & Seattle, with headquarters at Portland, Ore., succeeding J. E. Mahaney, resigned.

E. O. GRIFFIN, general storekeeper of the International & Great Northern, with office at Palestine, Tex., has been appointed also general fuel and supply agent.

H. L. RICHARDSON has resigned as fuel agent of the St. Louis, Brownsville & Mexico at Houston, Tex., and the office has been abolished.

C. T. TILLMAN, treasurer and acting purchasing agent of the South Georgia, at Quitman, Ga., has been appointed purchasing agent with office at Quitman.

OBITUARY

A. B. ADAMS, division master mechanic of the Gulf, Colorado & Santa Fe at Silsbee, Tex., died suddenly on February 16, aged 49 years.

NEWELL S. KIMBALL, for 30 years district master mechanic of the Chicago, Milwaukee & St. Paul at Green Bay, Wis., died in Chicago on January 31, aged 82 years.

SUPPLY TRADE NOTES

Edward W. Hodgkins has resigned his connection with Guilford S. Wood, Chicago, to engage in business for himself.

Karl A. Heine has joined the sales department of the Chicago Car Heating Company, with office in the Grand Central Terminal building, New York City.

John L. Randolph has been appointed eastern sales manager of the Economy Devices Corporation, 30 Church street, New York. Mr. Randolph was born in Boston, Mass., August 25, 1878, attended the public schools and was graduated from the English High School of that city. His railroad career began as a machinist apprentice in the Concord, N. H., shops of the Northern Railroad now a part of the Boston & Maine. Subsequently he served this road in the capacity of machinist, gang foreman, general foreman, master mechanic, and superintendent of shops at Keene, N. H. In April, 1911, he accepted a position with the Franklin Railway Supply Company in the mechanical department and remained with that company until February 1, 1914, when he was appointed eastern sales manager of the Economy Devices Corporation, as noted above.

J. L. Randolph

Earl A. Averill has resigned as managing editor of the Railway Age Gazette, Mechanical Edition, and on March 1 goes with the Standard Stoker Company, Grand Central Terminal, New York, as engineer of operation. Mr. Averill joined the staff of the American Engineer and Railroad Journal on January 1, 1906, as an editor, and on April 1, 1910, became managing editor. He has continued in that position since the purchase of that publication by the Simmons-Boardman Publishing Company. He was born at Richland, N. Y., on August 13, 1878, and after a preparatory education in public and private schools, entered Cornell University in 1896. He was graduated in 1900 with the degree of mechanical engineer, having specialized during his senior year in railway mechanical engineering. He began his practical railroad work in the summer of 1899 in the shops of the Philadelphia & Reading, Reading, Pa., and, on graduation, went with the Chicago, Burlington & Quincy, at West Burlington, Ia., reporting to J. F. Deems, who was then master mechanic at that point. After four years' service with the Burlington, most of which was spent in the shop, roundhouse and on the road, Mr. Averill joined the staff of the Railway and Engineering Review of Chicago, where he remained for over two years. He left that publication to come to New York with the American Engineer and Railroad Journal. With the Standard Stoker Company he will have charge of the installing and preliminary operation of the stokers as well as all tests, records of service, etc.

E. A. Averill

W. F. Bauer has resigned from the United States Light & Heating Company, to become assistant manager of the railway department of the Edison Storage Battery Company, Orange, N. J.

A. C. Adams has resigned his position of superintendent of motive power of the Spokane, Portland & Seattle to become the Pacific coast general agent of the General Brake Shoe & Supply Company, Chicago, and will have headquarters at 907-908 Wilcox building, Portland, Ore.

The Chicago Car Heating Company has recently opened a branch office and factory at 61 Dalhousie street, Montreal, Canada. A. D. Bruce, former purchasing agent of the company at Chicago, is in charge. Mr. Bruce is a native of Guelph, Ont., but has been connected with the Chicago Car Heating Company in Chicago for the past five years.

Bertram Smith has been appointed assistant manager of the Edison Storage Battery Supply Company, San Francisco, which handles the Edison battery on the Pacific coast. Mr. Smith started in the storage battery business in 1899 with the National Battery Company, Buffalo, N. Y. He was secretary and treasurer of that company for three years, but since its absorption by the United States Light & Heating Company, he has been manager of the latter company's battery department.

Charles Henry Schlacks, whose election to the presidency of the Hale and Kilburn Company, Philadelphia, Pa., was announced in the February issue, was born in Chicago on November 12, 1865. He entered railway service when he was but fourteen as an office boy on the Illinois Central. He then became a machinist's apprentice, and was consecutively to 1891 mechanical draftsman, chief clerk to the superintendent of machinery and chief clerk to the general superintendent. In November, 1891, he was appointed assistant to the general manager of the Denver & Rio Grande. On November 1, 1894, he became assistant general manager of that road and retained that position until July 1, 1900, when he was appointed also general manager of the Colorado Midland. On June 1, 1904, he became a vice-president of the Denver & Rio Grande. On November 5, 1909, he also became the first vice-president of the new Western Pacific, the western extension of the Denver & Rio Grande, removing his headquarters to San Francisco, Cal., and was an important factor in the work of getting that road in complete and efficient working order. He was thus for a time the first vice-president of the Western Pacific, vice-president of the Denver & Rio Grande, the Colorado Midland, the Rio Grande Southern and the Utah Fuel Company, and president of the Globe Express Company.

C. H. Schlacks

CATALOGS

HYDRAULIC PRESSES.—Heating, chilling and die presses are fully illustrated and described in a 56 page catalog issued by the Watson-Stillman Company, 50 Church street, New York. This is catalog No. 89.

MECHANICAL RUBBER GOODS.—Valve discs, sheet packing, pump valves, gaskets and other similar mechanical rubber parts are illustrated and described in a small catalog issued by Jenkins Bros., 80 White street, New York.

BRAKE SHOES.—The Pittsburgh brake shoe has a steel shell filled with composition and gives a very high friction with a long wear. It is illustrated and described in a leaflet being issued by the Pittsburgh Brake Shoe Company, Farmers' Bank building, Pittsburgh, Pa.

HAND-TRAVELING CRANES.—The Brown Hoisting Machinery Company, Cleveland, Ohio, is issuing a leaflet descriptive of the Brownhoist single I-beam, hand-traveling crane which is built for easy operation and long life. The illustrations show a number of the more interesting details.

LOCOMOTIVE CRANES.—A 55 page book from the Industrial Works, Bay City, Mich., illustrates and describes locomotive cranes for construction, industrial and railroad purposes. This is known as book No. 108 and is a most attractive publication typographically. Some of the illustrations are given in color and all are most interesting. It shows locomotive cranes working under a variety of conditions and illustrates many special designs. Wrecking cranes are given a section of the book.

DRILLS, REAMERS, ETC.—Catalog No. 15 of the Rich Tool Company, Railway Exchange, Chicago, illustrates and clearly describes a complete line of high speed twist drills, reamers, track bits, flat drills, bonding drills, drill chucks, reamer chucks and rivet sets manufactured by this company. Tables of sizes and prices accompany each style illustrated.

CHAIN DRIVE.—A leaflet from the Morse Chain Company, Ithaca, N. Y., gives short descriptions of typical Morse silent chain drives, showing their durability and efficiency for long periods of time. Many of these applications are to motor driven machine tools. A table is inserted showing a list of the installations of thirty-one original chain drives in the shops of the Pittsburgh & Lake Erie at McKees Rocks. This table shows the present condition of drives that have been in regular service from five to ten years each.

BULLSEYE LOCOMOTIVE LUBRICATORS.—An attractive 56 page catalog No. 36L has been issued by the Detroit Lubricator Company, Detroit, Mich. It fully describes the principle of the hydrostatic lubricator and the features of design of the modern types of bullseye lubricator. The latest developments in this line are illustrated in a complete manner and instructions for operating, cleaning and adjusting are included. The Detroit transfer filler which will allow the lubricator to be refilled at any time while in service, is also discussed at some length. Accessories in connection with the lubrication of locomotives are shown.

LOCOMOTIVE RATIOS.—Bulletin No. 1,017 from the American Locomotive Company, 30 Church street, New York, is devoted to a discussion of locomotive ratios by F. J. Cole, chief consulting engineer. Included in the discussion are a number of very valuable tables of reference giving cylinder horse power of saturated and superheated steam locomotives for various pressures and diameters of cylinders; evaporation from tubes and flues in pounds of steam per hour per square foot for different diameters and lengths; heating surface of tubes for different diameters and lengths and the ratios of the outside heating surface to the diameter and spacing of tubes. The discussion of the various ratios is largely confined to features of the boiler and present a number of new proportions which have been thoroughly tried out in practice and are known to be correct.

ELECTRIC STEEL CASTINGS.—The process of making electric steel consists of melting down a charge directly in an electric furnace or in transferring molten steel from the open hearth or Bessemer convertor to an electric furnace and there maintaining the charge in a molten state under complete chemical control in a neutral atmosphere, until it is refined and purified. It is claimed that this method will allow a production of steel which possesses certain characteristics and advantages to a degree not found in ordinary processes. This material gives castings which have the highest degree of uniformity combined with great toughness, strength and flexibility. Illustrations of the furnaces used and discussion of the product, including the results of a number of tests are given in a catalog which is being issued by the National Malleable Castings Company, Sharon, Pa.

DUMP CARS.—Extension side dump cars of from 12 cu. yd. to 20 cu. yd. capacity are the subject of a catalog being issued by the Clark Car Company, Pittsburgh, Pa. In this type of car a new feature is presented which consists of having the side of the box turned downward as the box is inclined which makes an extension or shelf that protects the truck and track from back filling and leaves a clear space above to discharge the load. It is claimed that this arrangement improves the construction of the car by permitting the sides to be hinged to the body throughout their length, and by having side operating cross frames at intermediate positions as well as at the ends of the car. These cars are made with air or hand operating mechanism or the two can be combined. The catalog shows a number of illustrations and contains a very complete description of all the features of construction.

HEATING AND VENTILATION.—It was over 25 years ago that the first edition of the book known as "Heating and Ventilation," was published by the B. F. Sturtevant Company, Hyde Park, Boston, Mass. Since that time frequent new editions have been brought out, keeping pace with the increased knowledge of the subject and the improvement in the apparatus, but until the present edition, no decided change was made in the form of book. Recently, however, the advancement in this line has been so rapid that it has made it necessary to revise the book completely. In doing this an endeavor has been made to make it more generally useful as a book of reference which will be equally valuable to the engineer and to the layman. The arrangement has therefore been changed and the index has been made more thorough. It is in two parts. The text matter makes up part one and is divided in ten chapters which are further divided in sections, all numbered and provided with titles to aid the reader in finding the information he desires. The second part is a collection of tables for the use of the student and engineer covering the subject of heating and ventilation in general and of the Sturtevant apparatus in particular. The ten chapters in the first part are on different subjects as follows: Chapter 1 considers air, its composition, properties and principal characteristics. Chapter 2 deals with the subject of ventilation; chapter 3 with heat; chapter 4, the Sturtevant system of combining heating and ventilation, and chapter 5 a general study of the apparatus used in heating and ventilating installations. Chapter 6 gives assistance on the considerations of problems involved in calculating heating and ventilating systems. Chapter 7 is devoted to the testing of the system. Chapter 8 is a consideration of the individual problems involved in the ventilation and heating of distinctive types of buildings and chapter 9 is a description of typical installations and apparatus. Chapter 10 briefly describes Sturtevant apparatus. The tables are very complete and cover practically all the information that is necessary for a detailed and extensive investigation of this subject.